How to Build an Audio Ear

January, 1959
IND

Radio-Electronics

HUGO GERNSBACK, Editor

Signal-Level Comparator for Audio Amplifier Checking

Use Portable Equipment In Color TV Servicing

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See page 4

35c
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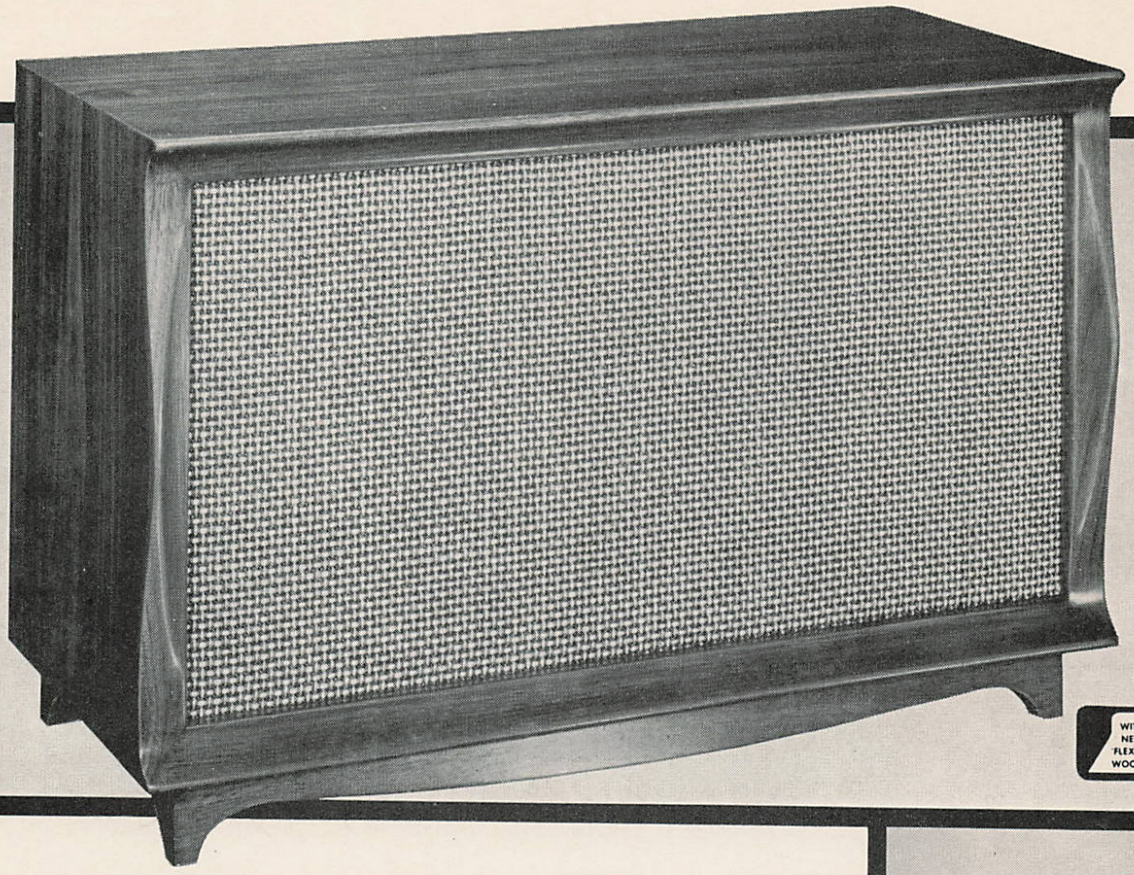

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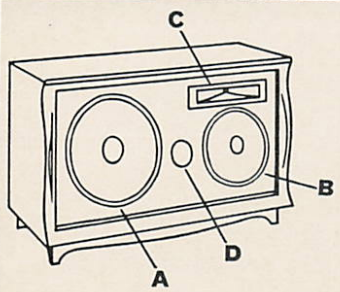

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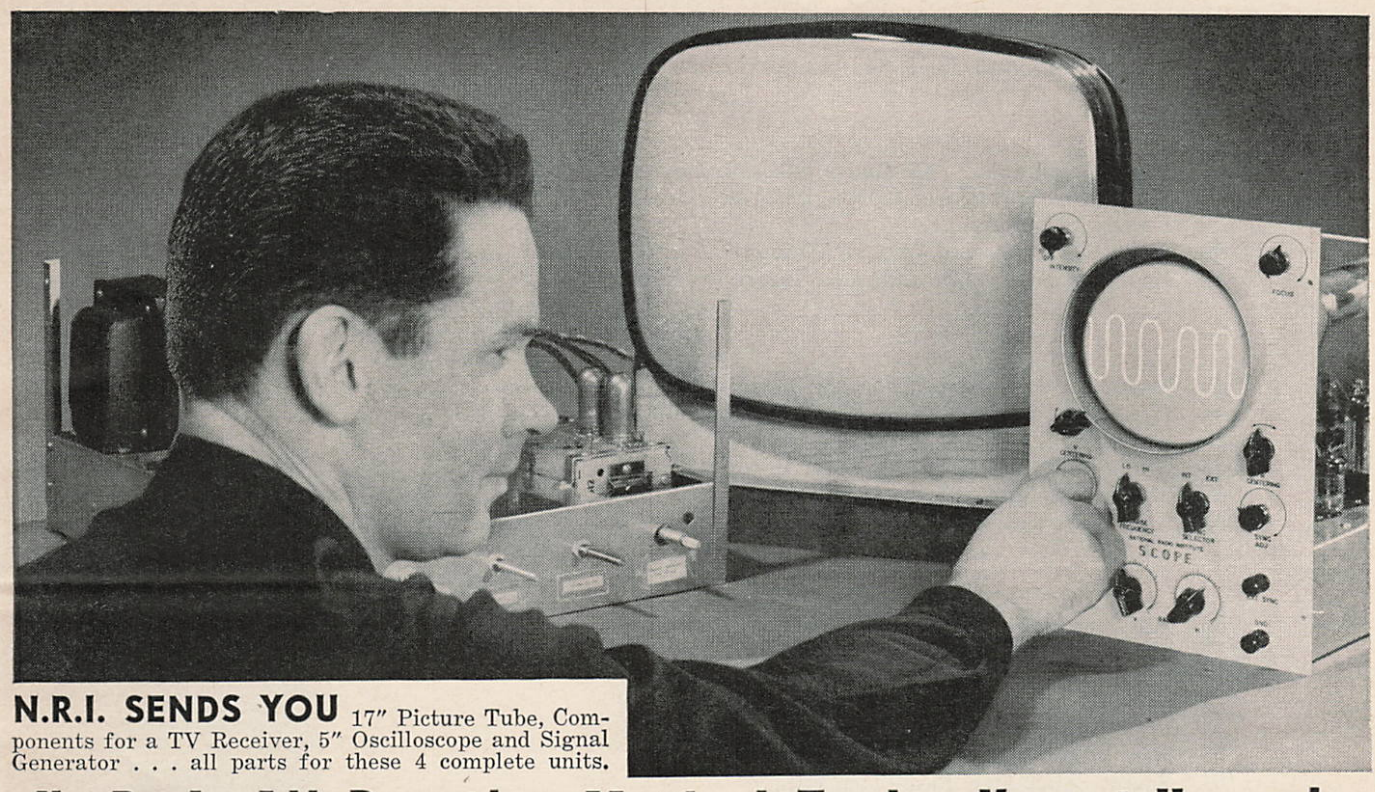

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EDITORIAL

33 Stored Television Reception—Hugo Gernsback

ELECTRONICS

34 Highway Safety . . . Challenge to Electronics—David Lachenbruch
37 Computers Speed Aircraft Design (Cover Feature)—Forrest H. Frantz, Sr.
39 Electronic Crossword—Wm. R. Shippee
40 Improved Solar Flare Indicator—David Warshaw

AUDIO—HIGH FIDELITY

42 Audio Ear in Your Shirt Pocket—Edwin Bohr and Gordon Peters
44 How Much Power for a Stadium?—Herman Burstein
45 Stabilizing Feedback Amplifiers, Part I—Herbert I. Keroes
48 A Box for Your Speaker—P. G. A. H. Voigt
51 Stereo Disc Standards
51 New Discs and Tapes, Stereo and Mono—Reviewed by Chester Santon

RADIO

53 ABC's of Mobile Radio, Part I—Leo G. Sands
57 FM Tuner for Your Car—Henry O. Maxwell

TEST INSTRUMENTS

58 New Kind of Audio Oscillator—Robert F. Scott
61 Simple Super Time Base—Tom Jaski
76 Audiophile's Signal-Level Comparator—J. E. Pugh, Jr.
81 Low-Capacitance Probe—Robert G. Middleton

WHAT'S NEW?

84 Pictorial Reports of New Developments

TELEVISION

85 Portable Test Instruments in Color TV—Robert G. Middleton
98 TV Dx in '58—Robert B. Cooper, Jr.
106 Television Station List—Compiled by Muriel I. Schiller
108 TV Remote Volume Control—Harold Reed
110 TV Service Clinic—Conducted by Robert G. Middleton

143 Books
138 Business and People
142 Correction
16 Correspondence
141 Literature
118 New Tubes and Semiconductors
6 News Briefs
123 Noteworthy Circuits
126 On the Market
132 Patents
114 Technicians' News
134 Technotes
136 Try This One
125 50 Years Ago

ON THE COVER

(Story on page 37)

Experimental test pilot Robert Rostine "flies" an as-yet-unbuilt aircraft as Greta Beckler changes a connection on a Heathkit analog computer used to simulate an aircraft control, in a cockpit test at Chance Vought Aircraft, Dallas.

Color original by Ari Schoeni

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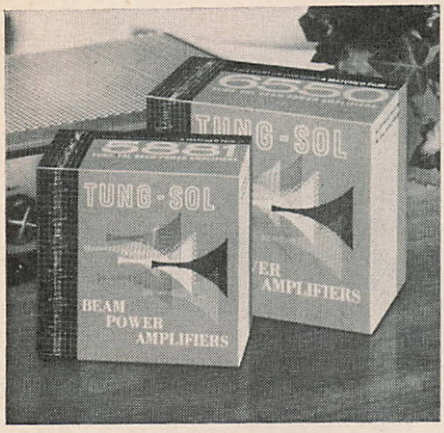

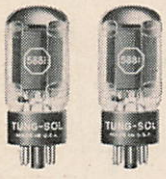

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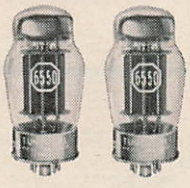

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STEREO RADIO STANDARDS will be proposed by an all-industry group similar to the one which selected the current systems of black-and-white and color television.

A National Stereo Radio Standards Committee, to test all stereo broadcasting systems and make recommendations to the FCC, is being established by the Electronic Industries Association (EIA). Heading the NSRSC's administrative committee will be Dr. W. R. G. Baker, who was chairman of the pioneering National Television System Committee (NTSC). Dr. Baker, former president of EIA and vice president of General Electric, now is EIA engineering director and head of the Syracuse University Research Corp.

The entire electronic industry will be invited to serve on NSRSC. Its goal will be the formulation of standards for a single stereo broadcasting system which is both compatible and inexpensive to the public.

FCC officials indicated they welcome the formation of the industry committee. The commission is now studying the various stereo radio systems, and no decision on standards is expected for a considerable time—probably not for a year or more.

More stereo radio systems undoubtedly will be proposed, but these are the compatible ones which already have been developed and demonstrated:

1. The Crosby sum-and-difference FM system. The main channel carries the sum of the two signals, the multiplexed subcarrier the difference. A converter matrixes these channels into the proper left and right signals.

2. A system somewhat similar to the Crosby proposal, but which permits the use of a second multiplexed channel for a "second program" of specialized music or information beamed to stores and offices while the stereocasting is carried by the first two channels.

3. The RCA compatible AM stereo system, demonstrated recently at RCA Laboratories in Princeton, N. J. Each of the stereo channels is carried by one sideband of the AM carrier. The stereo receiver uses a conventional rf amplifier, converter and if amplifier. Sideband selectors then pick up the upper and lower sidebands separately, detect the signal and amplify it to be fed into the left and right speakers.

4. The Percival system, developed by EMI Ltd. of England and tested by the British Broadcasting Corp. Adaptable to either FM or AM, it transmits a conventional broad-band signal (monophonic) plus a narrow band of directional information for use by stereo receivers.

TRANSATLANTIC HI FI is in sight—in fact, it was approached in the recent United Nations Day international concert featuring orchestras in Geneva, Paris and New York, marking the first use of the new transoceanic cable to carry music.

As a result of more than 6 months of painstaking tests directed by UN Radio operations manager Joe Nichols, East Coast FM listeners were able to hear the Paris concert with a frequency response up to 6,500 cycles, and British listeners received the New York concert with the same fidelity. Conventional network transmission lines in the US often do not pass frequencies higher than 4,000 cycles, and rarely more than 5,000.

The feat was accomplished after many frequency runs conducted experimentally by dividing various bands of frequencies among different lines within the cable. In this country, the program was carried in its full fidelity by the New York and New England FM Concert Network, the New York State WQXR Network (FM) and by FM stations in Philadelphia and Washington.

AMERICANS VIEWED a Eurovision telecast for the first time Nov. 4 when Videotape extended the 12-nation European TV network to the US for televising the coronation of Pope John XXIII from the Vatican.

The taping was done in the studios of Granada Television in Manchester, England, with an Ampex Videotape recorder on the 525-line US television standards—but the signal underwent considerable metamorphosis between the camera pickup and the recording.

The TV pickup at the Vatican was made with cameras of Radiotelevisione Italiana (RAI), the Italian broadcasting company, using the European 625-line standard. Fed through 23 microwave hops, the 625-line picture was received from France at Dover, England, across the Channel, where it was converted to the 405-line British standards. The conversion device uses an image orthicon camera to take a 405-line picture directly from a 625-line monitor.

The 405-line picture was microwaved to Manchester, where it was converted—again by optical means—to the 525-line standard used by American TV stations. Then it was fed into the Videotape recorder and a running commentary interpolated.

The 55-minute tape was put aboard an airliner for New York and rushed

(*Continued on page* 10)

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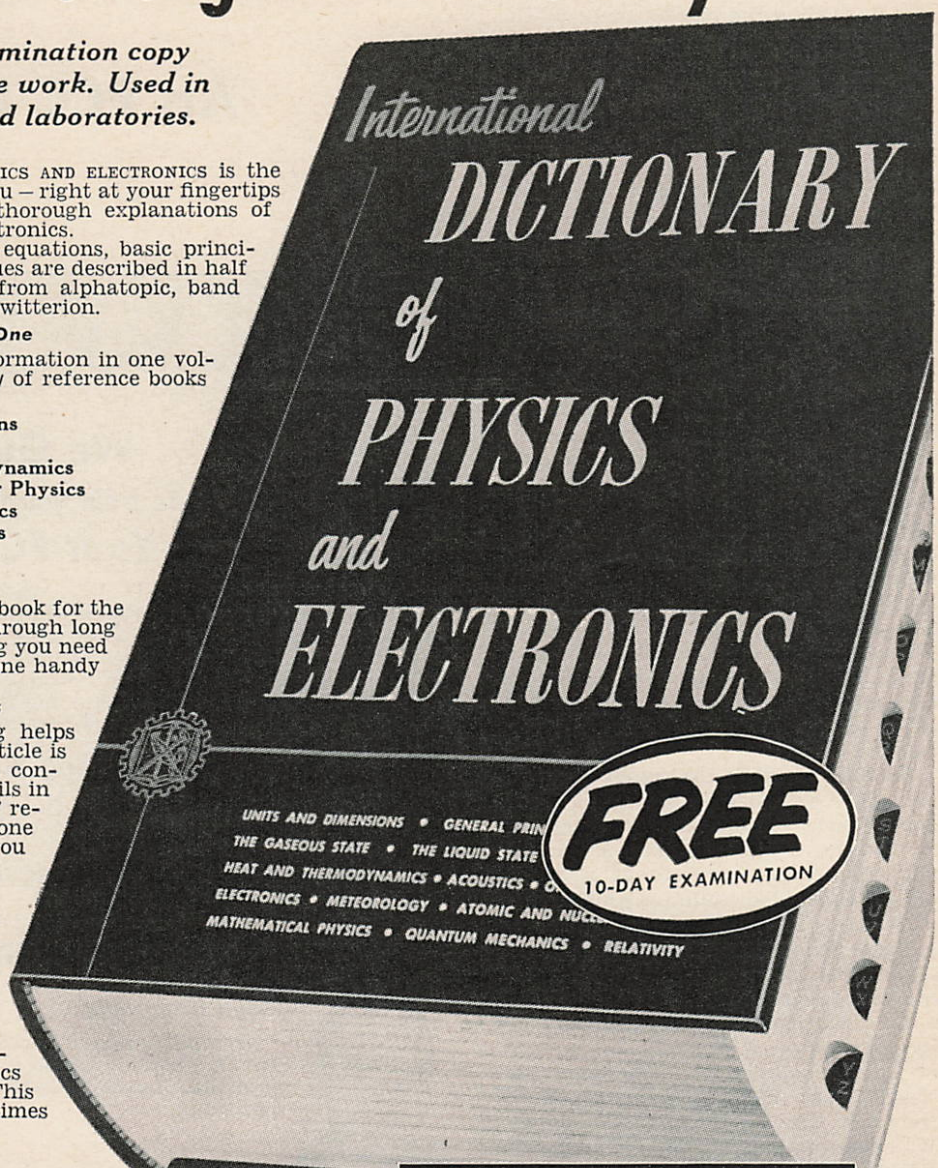

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to the Columbia Broadcasting System studios for a nationwide telecast. The quality of the picture was surprisingly good.

The 525-line Videotape recorder in Manchester, England, was purchased by Granada TV for showing taped American TV programs. An electronic system to convert 525-line TV pictures to 405 lines is being developed by Granada.

SELF-THREADING CARTRIDGE is being tested by tape recorder manufacturers and may be on the market in 1959. The new single-reel tape magazine differs in many respects from the two-reel tape cartridges now in use.

Developed by Armour Research Foundation of the University of Illinois, the cartridge consists of a single flanged reel of tape and a graded leader tape with a catch on it. The catch engages with a pre-threaded leader which is a part of the recorder mechanism. When forward recording is completed, an end leader automatically reverses the drive for rewind or operation in the reverse direction.

The self-threading device can be installed on conventional tape recorders, or the tape cartridge can be used on nonequipped recorders by removing the leader tape.

TWO HAM RECORDS for long-distance transmission using all-transistor equipment were made during last September by West Coast amateurs. Donald L. Stoner, W6TNS, Ontario, Calif., established contact with ZS6KD, Johannesburg, South Africa, over a 16,000-mile transmission path, on the 20-meter phone band using single-sideband equipment.

ZS6KD described the signals as weak but 100% readable. Stoner's rig operates from a 15-volt battery, supplying 90-mw power input to the final amplifier. The circuit consists of a 2N371 crystal-controlled oscillator which drives a 2N370 as a class-C rf amplifier.

Major Gilbert, K6LMW, an engineer at Hoffman Laboratories, Los Angeles, conversed with two other hams 2,000 miles away, using a transmitter and receiver powered entirely by a bank of silicon solar cells. His "loud and clear" voice signal was received by Henry A. Kusek, W9KZX, Chicago, and W. Leonard Gregory, Jr., W9RLY, Mt. Prospect, Ill., on the 10-meter band. He used 72 solar cells, providing a transmitter power output of 60–75 mw.

ULTRASONICS will soon be helping farmers decide which of their livestock to send to market and will be providing housewives with more uniform, leaner meat. In both the US and Britain, ultrasonic devices designed to measure the depth of flaws or impurities in metals are being used experimentally to measure the thickness of the fat and lean on meat-producing animals.

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Irving L. Laing,
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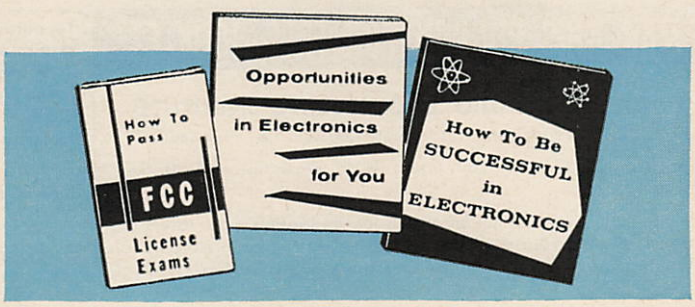

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The FEBRUARY issue of RADIO-ELECTRONICS goes on sale January 29 at all better parts distributors and newsstands.

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outer hide and bounce back from the borders between fat and lean meat and bone. The time differences are read on a cathode-ray indicator and translated to inches of fat and lean. A US Agriculture Department official predicts that within 2 years a simplified ultrasonic meat meter will be available to farmers and ranchers for pretesting the meat on cattle and pigs.

BATTERY-OPERATED FM receivers will be possible very soon using a new series of drift transistors, RCA's Semiconductor and Materials Div. has announced. The transistor types, now ready for pilot production, are designed for use as rf amplifier, mixer, oscillator and if amplifier.

Calendar of Events

Hi-Fi Music Show, Jan. 9–11, Dyckman Hotel, Minneapolis, Minn.
Symposium on Reliability and Quality Control, Jan. 12–14, Bellevue Stratford Hotel, Philadelphia, Pa.
Minneapolis Hi-Fi Music Show, Jan. 16–18, Hotel Leamington.
Indianapolis Hi-Fi Music Show, Jan. 30–Feb. 1, Hotel Antlers.
San Francisco High Fidelity Show, Feb. 7–10, Cow Palace.
Solid State Circuits Conference, Feb. 12–13, University of Pennsylvania, Philadelphia, Pa.
Los Angeles High Fidelity Show, Feb. 18–22, Biltmore Hotel. RADIO-ELECTRONICS will exhibit.

RADIOACTIVE CLOUDS have been spotted and tracked by radar. The Army Signal Corps, using advanced weather radar equipment, was able to measure the size and plot the course of "hot" clouds which formed after a nuclear test. The Army said such information on the height and drift of nuclear clouds would be valuable for providing fallout warning to civilians and troops.

LONGEST SINGLE-HOP tropospheric scatter system ever developed has been installed by General Electric between Boston, Mass., and Winston-Salem, N. C. It spans a 640-mile distance and is the prototype of a system to be used by the Air Force as the main communication line between advanced Arctic bases.

Two 50-kw single-sideband transmitters at each site feed into two antennas with 120-foot parabolic reflectors, transmitting 1,000,000,000 watts of effective radiated power. The two-way system has 24 voice and teletype channels and is expected to be "99.9% reliable."

MAGAZINE THAT TALKS and plays music is on the newsstands in Paris. *Sonorama,* a news and entertainment publication, contains six thin plastic "sound pages" which alternate with printed pages. A center hole through the entire magazine permits readers (or listeners) to play the sound pages on their phonographs and hear latest song hits, excerpts from theatrical productions, on-the-spot recordings of current events and voices of leading personalities. END

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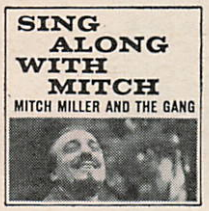

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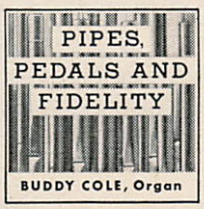
10. A truly magnificent performance of this majestic symphony

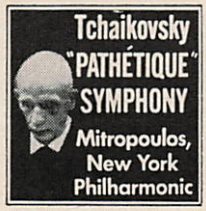
11. The great tunes from Rodgers and Hammerstein's fabulous hit

12. The two fiery Roumanian Rhapsodies—plus 2 more works

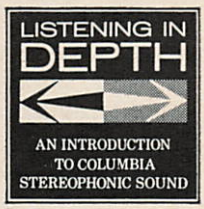


13. Organist Buddy Cole plays 11 tunes—Mine, Caravan, Carioca, etc.

14. Cugi's greatest hits—Besame Mucho, Tico-Tico, Brazil, 9 more



15. The most popular of Tchaikovsky's lovely, melodic symphonies



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6. Lester Lanin at the Tiffany Ball
7. Bells Are Ringing — Original Broadway Cast
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9. Black, Brown and Beige
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11. Percy Faith Plays "South Pacific"
12. Roumanian Rhapsodies 1, 2; plus two more works
13. Pipes, Pedals and Fidelity
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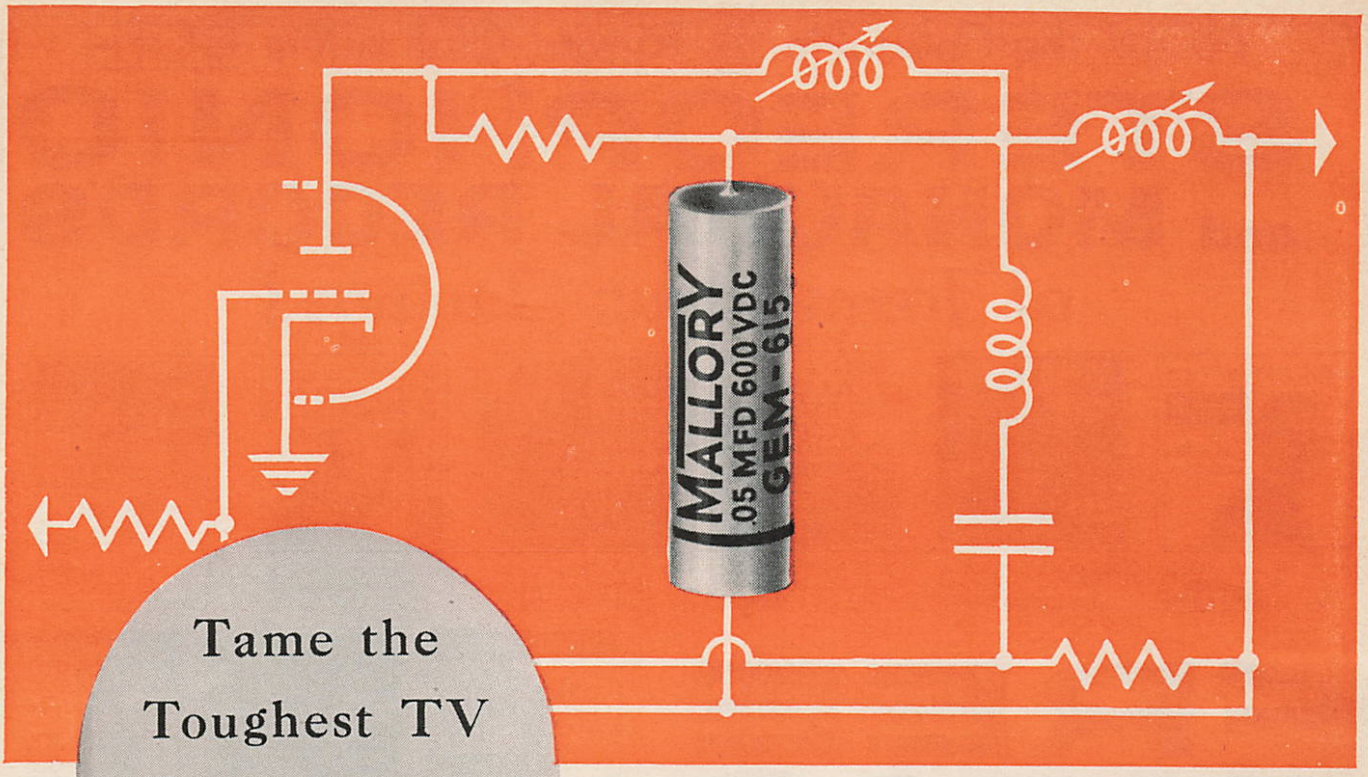

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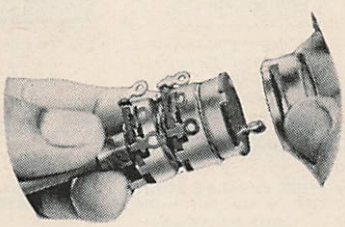

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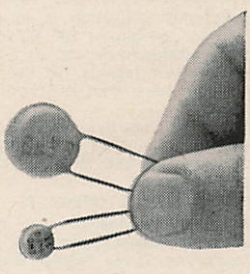

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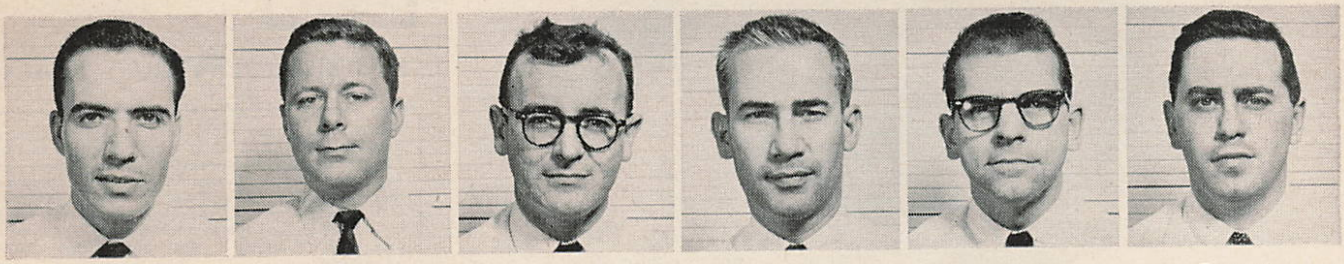

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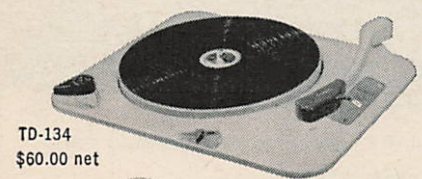
WHAT MAKES THE TD's TOPS?

...finer for stereo...finer for mono

If you move in circles where component hi-fi is a by-word, you've no doubt heard about the Thorens TD-124 transcription turntable and its fabulous performance. But for late-comers we'd like to point up just a few of the really big features (non-technical readers may skip remarks in parentheses): • **Extra heavy table for constant speed** (10 lb rim-concentrated table insures low wow and flutter; higher moment of inertia than any similar table). • **Exact speed** (±3% adjustment on all speeds—16⅔, 33⅓, 45, 78—with built-in illuminated strobe for setting after stylus is on record). • **Easy on records** (unique two-table design permits starts after you've placed stylus, permits ⅔ rev. starts, makes cueing easy). • **Extremely low rumble** (mirror-finish main-bearing, nylon-seated ball-thrust-bearing reduce both vertical and horizontal rumble to a new low, so important for stereo). • **2-way motor rumble reduction** (both an extra-large idler and an ultra-compliant belt-drive keep motor vibration and speed variations from table). Driving parts electronically balanced. No costly base necessary (only $9.00). 50/60 cycles, 100/250 volt operation.

These are just a few of the TD-124's features. Ask your dealer to tell you the whole story on the fabulous TD-124.



Now two budget-priced TD turntables

These 4-speed turntables have same basic adjustable-speed precision-drive as famous TD-124 but you save two ways: (1) they come already equipped with stereo-wired professional arm without overhang making them ideal changer replacements. (2) Some TD features have been eliminated to save you money. But they still top the performance of every similar turntable and player on the market. TD-184 has semi-automatic operation. TD-134 is manually operated. Precision metal stroboscope (50/60 cycles) furnished with each unit. 100/250 volt operation. Wooden base only $6.00.

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Correspondence

TV MAN RIDES GRAVY TRAIN?

This article in our November issue was clearly marked as directed at a racket harmful to the TV repair technician—certainly *not* aimed at TV service as a whole. These letters indicate that the article was not clearly enough flagged. Our apologies to any technicians who may have been offended by the story, and may we suggest they read it again in the light of this correspondence?

Dear Fred:

After hearing numerous complaints about an article, "The TV Man Rides the Gravy Train," by E. H. Leftwich, in your November issue (page 98), I just had to read it despite an almost continuous series of trips that have kept me on the run. Frankly, Fred, had this article appeared in the April issue I would think it was an April Fool gag.

Just who this author is, I don't know, but quite obviously he is *not* a professional home electronics technician and certainly not a businessman or an accountant. His explanation of why he doesn't do TV work, how he went about picking a TV servicer for himself, and his manner of diagnosing trouble are *not* those of a professional servicer; in fact, they are typical of a set owner who "knows it all." This is borne out further in his accounting procedure. Who ever heard of 15 calls per day, especially day in and day out, even assuming a 12-hour day? Further, I would like to see the shop, especially a schlock operator such as he implies, getting 540 calls per week.

We would be most anxious to learn the author's address and business name. We are certain that he is not a professional servicer, even though he describes himself as an electronics engineering writer (what school did he get his degree from?), but also is *not* an author except of purely fictional twaddle, unworthy of publication in any magazine. FRANK J. MOCH
Executive Director, National Alliance of Television & Electronic Service Associations
Chicago, Ill.

REPLY TO MR. MOCH

Dear Frank:

I was rather surprised to get your letter. Of course, we had expected some objections to the "Gravy Train" story, chiefly from two types of readers. The first is the literal-minded type who does not expect to find humor or hyperbole in a technical magazine and asks us if the April Fool stories are really just jokes. Even the vastly exaggerated and burlesqued attack on the aggressive do-it-yourselfer, "Beware the Serviceman" which ran in our September,

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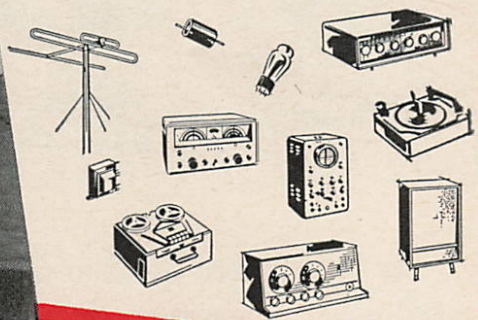

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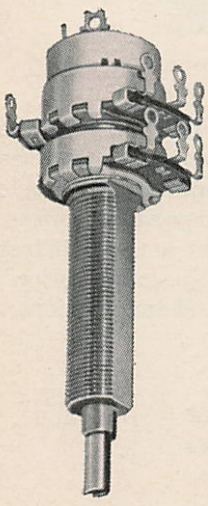

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1945, issue, drew some protests from that group. Second, individuals in the "Trustworthy TV" class would no doubt react vigorously. We believe that they form a very small part of our readership, since not only are they few in numbers, but are usually composed of persons not interested in the technical side of the business, and therefore unlikely to read a technical magazine.

We did not expect to get protests from the bulk of the TV service business, since the racket to which we are calling attention may be as harmful to the legitimate technician as the $1-per-call and other fly-by-nights we have attacked in the past. In some ways, it may be more harmful, since the "Trustworthy" type of operation clothes itself in bigness, puts up a legitimate-looking front, advertises widely and very actively competes for business. The little outfit working from a telephone number with no address is handicapped from the beginning, and it is easy to expose this type of operator to the customer. If stung by such an outfit, he resolves to deal with the legitimate field from then on. But if he is left with bad will by an outfit like "Trustworthy," he is likely to feel aggrieved at the whole service industry, since he is not as able to spot such organizations as racketeers. In fact, it is very hard for anyone to recognize them (till they are indicted).

Our mail on this has been smaller than I expected—only four letters to date, two of which were highly critical and two critical in a modified way. Yet two service associations have condemned the story, and you have received other complaints. Now, the "Trustworthy" type of company is just the one that does not join service associatons—they prefer to go it alone—so I cannot feel that the members of these associations recognize themselves in Leftwich's picture. Is it possible that in each of those meetings that the majority had not seen the magazine and had it described to them by the more emotional of those who had read it?

Obviously, we had no intention of attacking the TV service technician as such—our butter just isn't on that side of the bread, for one thing. What we *thought* we were doing was trying to point out a racket which we felt was doing harm to the legitimate service technician. Leftwich, I was sure, had the same idea. He does happen to be a legitimate electronics author, as you can see from page 39 of the same issue, and wrote the reply to the *Readers Digest* "expose" of infamous memory.

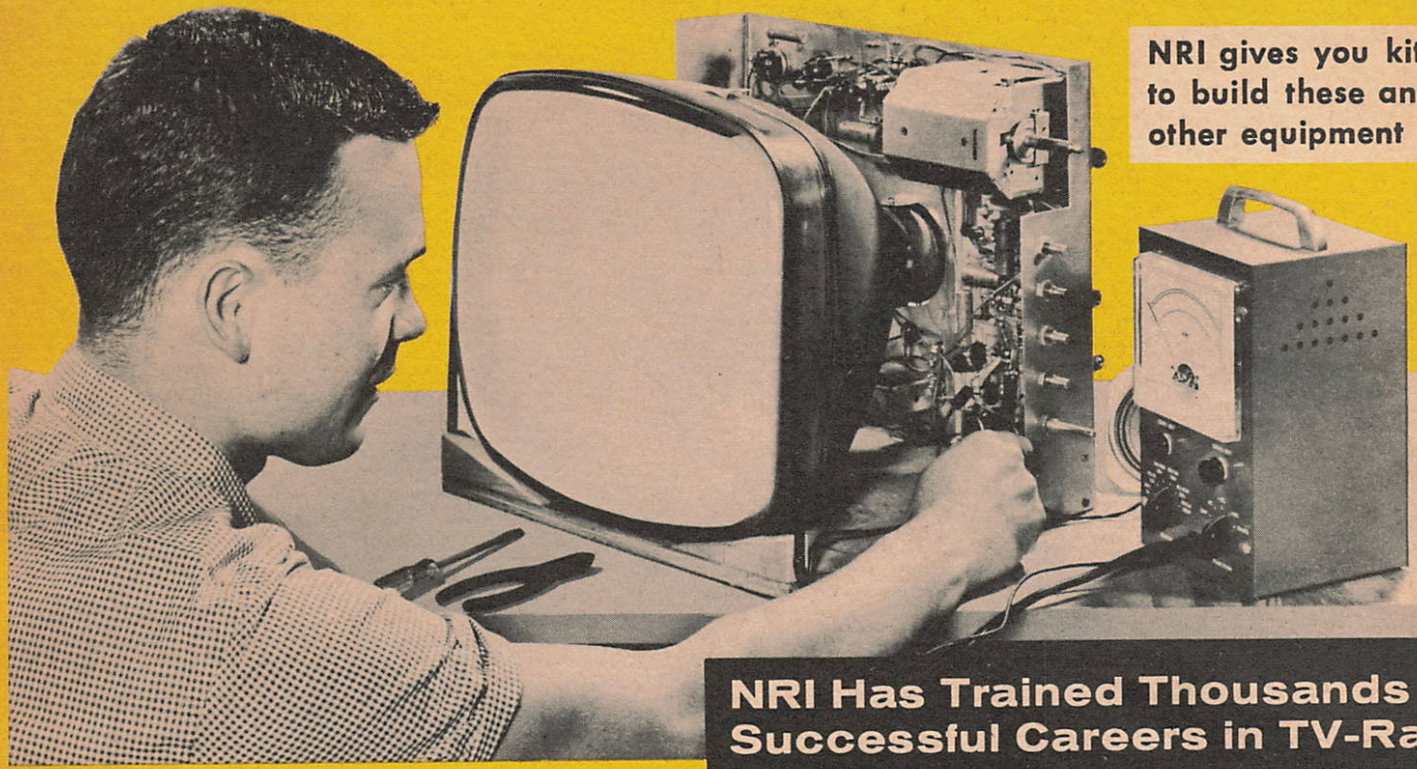
The 15 calls a day you mention are one short of what was required by a get-them-out-of-the-house outfit prosecuted here some years ago. It required that the field men make a call per half-hour for an 8-hour day. And even some legitimate businesses in this town

(*Continued on page* 22)

Learn TELEVISION-RADIO

Servicing or Communications

by Practicing at Home in Spare Time



NRI gives you kits to build these and other equipment

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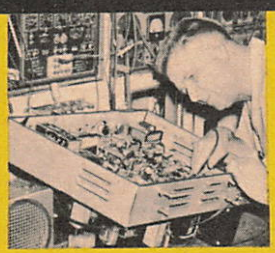
NRI students find it practical and profitable to start fixing sets for friends and neighbors a few months after enrolling. Picking up $10, $15 and more a week gives substantial extra spending money. Use the Tester built with parts NRI furnishes, to locate and correct Radio-TV receiver troubles. Many who start in spare time, soon build full time Television-Radio sales and service businesses; others enjoy profitable spare time businesses and the security of a source of income to fall back on in case of layoffs, hard times or other changes in regular job. Postage free card will bring you complete facts about the NRI tested way to better pay.

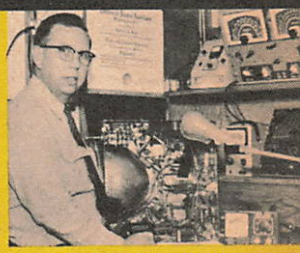
ACT NOW FIND OUT WHAT NRI OFFERS YOU

NRI Has Trained Thousands for Successful Careers in TV-Radio

Studio Engr., Station KATV
"I am now Studio Engineer at Television Station KATV. Before enrolling for the NRI Course, I was held back by limitation of a sixth grade education." BILLY SANCHEZ, Pine Bluff, Ark.



Has All the Work He Can Do
"Since finishing NRI Course I have repaired more than 2,000 TV and Radio sets a year. NRI training certainly proved to be a good foundation." H. R. GORDON, Milledgeville, Ga.



Has Good Part Time Business
"Quite early in my training I started servicing sets. Now have completely equipped shop. My NRI training is the backbone of my progress." E. A. BREDA, Tacoma, Wash.

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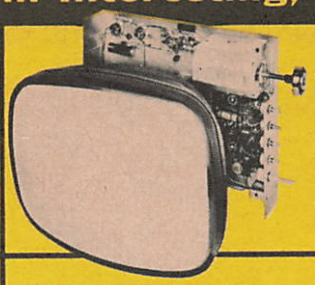
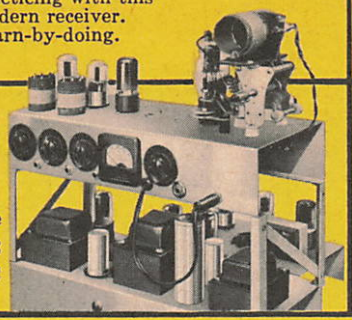


YOU BUILD This 17 Inch Television Receiver

As part of your NRI course you can get all components, tubes, including 17″ picture tube, to build this latest style Television receiver; get actual practice on TV circuits.



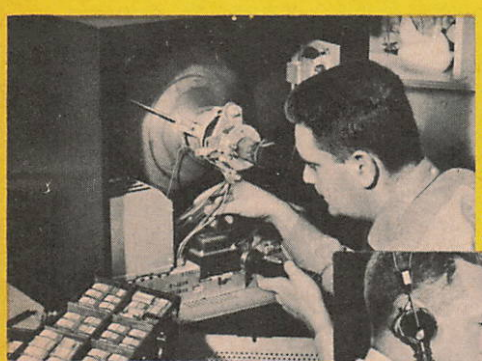
YOU BUILD Broadcasting Transmitter

As part of NRI Communications Course you build this low power Transmitter, learn commercial broadcasting operators' methods, procedures. Train for your FCC Commercial Operator's License.

YOU BUILD Vacuum Tube Voltmeter

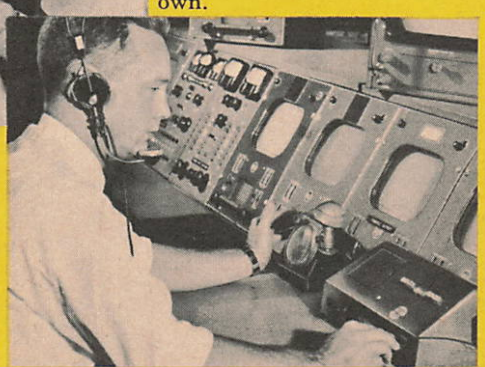
Use it to earn extra cash fixing neighbors' sets; bring to life theory you learn from NRI's easy-to-understand texts.

For Higher Pay, Better Jobs Be a TV-Radio-Electronic Technician



Servicing Needs More Trained Men

Portable TV, Hi-Fi, Transistor Radios, Color TV are making new demands for trained Technicians. Good opportunities for spare time earnings or a business of your own.



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4000 TV and Radio stations offer interesting positions. Govt. Radio, Aviation, Police, Two-Way Communications are growing fields. Trained Radio-TV Operators have a bright future.

J. E. Smith, Founder

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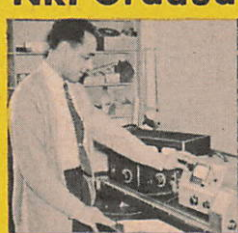
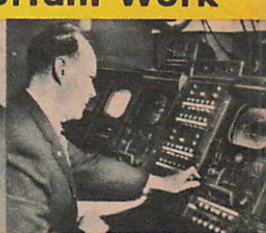
You don't have to know anything about electricity or Radio to understand and succeed with N R I Course. Clearly written, well-illustrated NRI lessons teach TV-Radio-Electronic principles. You get NRI kits for actual experience. All equipment is yours to keep. You learn-by-doing. Mailing the postage-free card may be one of the most important acts of your life. Do it now. Reasonable tuition. Low monthly payments available. Address: **NATIONAL RADIO INSTITUTE, Washington 16, D. C.**

NRI Graduates Do Important Work



Now Quality Control Chief
"Had no other training in Radio before enrolling, obtained job working on TV amplifiers before finishing course. Now Quality Control Chief." T. R. Favaloro, Norwich, N. Y.

NRI Course Easy to Understand
"I opened my own shop before receiving my diploma. I have had to hire extra help. I am independent in my own business." D. P. Cressey, Stockton, Cal.



Works on Color-TV
"NRI changed my whole life. If I had not taken the course, probably would still be a fireman, struggling along. Now Control Supervisor at WRCA - TV." J. F. Meline, NewYork, N.Y.

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"I find SAMS PHOTOFACT an absolute necessity in doing a job quickly and accurately... extremely helpful..."
—Dan M. Heinrich, *Westlake, Ohio*

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—Luther W. Wilkes, *Houtzdale, Pa.*

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"PHOTOFACT is used here every day, like an extra brain."
—Joseph M. Decker Jr.
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MASSACHUSETTS
"I would be lost without PHOTOFACT."
—Emilio Conzo, *Newton, Mass.*

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"Having data on sets plus parts listings, etc., means the difference between getting sets fixed and out in a reasonable length of time or having them tied up while securing such information, as I am located in a small town and have to depend on mail service for parts and information."
—Samuel S. Sawyer,
Kezar Falls, Maine

VIRGINIA
"I don't know how we would get along without PHOTOFACT, as we work on all makes and models."
—Kenneth E. Jenkins,
Big Stone Gap, Va.

CALIFORNIA
"With PHOTOFACT, the information I need is always at hand. I don't have to worry about a repair job because I know I will have a schematic that gives me correct information in the simplest possible form."
—J. R. Stukes, *Norwalk, Calif.*

WISCONSIN
"In my business, I service all makes of TV sets. Without good service literature such as PHOTOFACT, this would be an impossible task—especially to do a quick, intelligent job. In my estimation, Sams PHOTOFACTS is unequalled. I would hate to conduct a business without them. Keep up the good work!"
—Willard F. Dumke,
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"PHOTOFACT makes it possible to identify any part in any model TV... It is possible to locate trouble in almost any set through the use of Sams."
—Sam Rogondino, *Lake Forest, Ill.*

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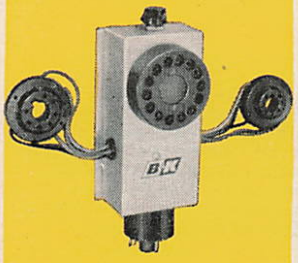

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get over 500 calls a week—the figure is not extraordinary, though they presumably do considerable servicing in the home and their calls would take more time. (A large legitimate concern in this city has a norm of 8 standard service calls per day, and pays a bonus of a dollar a call for all over the norm.)

Thank you for writing me immediately about this. You may make any use of this letter you desire.

FRED SHUNAMAN

Managing Editor,
RADIO-ELECTRONICS

MORE GRIEF THAN GRAVY

Dear Editor:

When I started reading "The TV Man Rides the Gravy Train" (RADIO-ELECTRONICS, November, 1958, page 98), I assumed that it was intended as pure fiction. But as I read on I realized that we were actually supposed to believe this trash. I have read Gernsback publications for more than the 16 years I have been in electronics service and I am surprised that you would print anything so stupid.

If these conditions exist anywhere in the US, it would be a good location for the many honest TV servicemen I know who aren't making a decent living. Many of the best former TV servicemen in Memphis are now working as truck drivers, policemen and factory workers because they couldn't make enough to get by at television service.

ALEX T. YATES

Memphis, Tenn.

(The unfortunate facts are that outfits like these mentioned by Mr. Leftwich make life harder—not easier—for the legitimate service technician, and that more than one of the "best former TV servicemen" are out of business because of the unfair competition of just such organizations.—*Editor*)

SUGGESTIONS TO LEFTWICH

Dear Editor:

Mr. Leftwich left out a few points:

1. He could have reported to the Better Business Bureau anyway—even though the repair shop was a member. Wouldn't they kick out an unsatisfactory member?

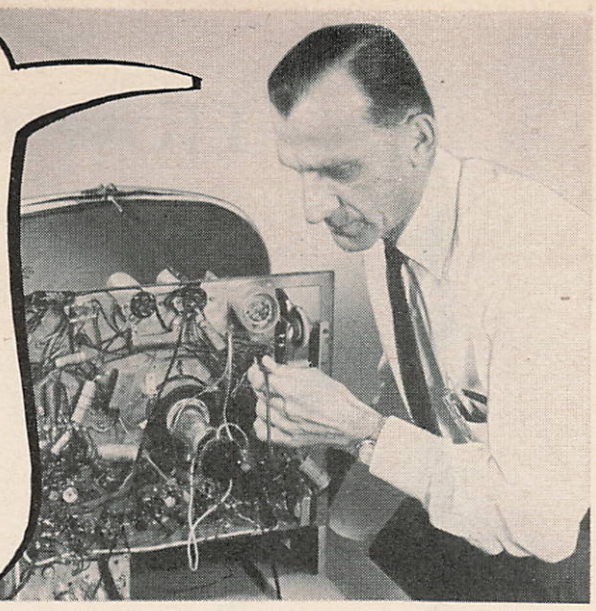
2. In his estimated budget for Trustworthy TV, he should have entered about $30,000 for bad debts. I, for one, wouldn't have paid, and would have sued if they had sold my set to cover repairs without *all* the legal formalities. So would many other people.

3. He should have gotten a loan set to use while his was in the shop. No charge, of course.

I sympathize, but I still think most technicians are good guys caught in the middle of an expensive operation. So, although I pal around with them, I do my own repair work on the three sets in use in my own household—*but no others.*

(Name withheld by request) END

I chose COYNE TELEVISION RADIO-COLOR TV home training because Coyne has been training men for good jobs OR their OWN BUSINESS for NEARLY 60 YEARS



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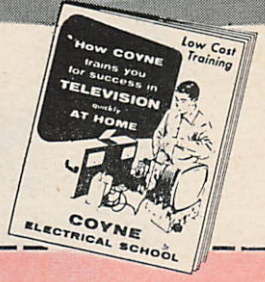

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B. W. Cooke, Jr.
President

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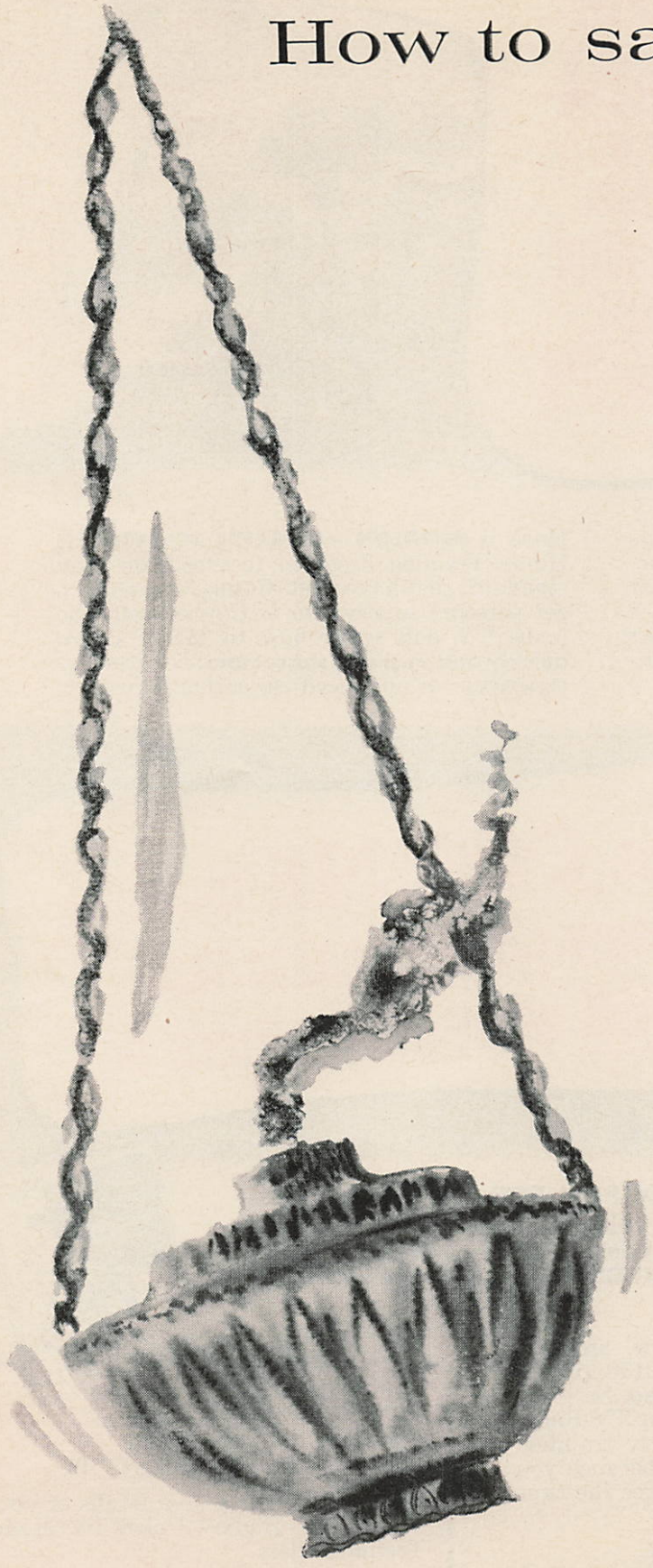
How to save 77 years



The boy Galileo sat in the sanctuary of Pisa's great cathedral, observing the movement of a lamp which had been set swinging by a sudden gusty draft. The chain by which it was suspended from the high ceiling was of such a length that the arcs decreased but slowly. Strange thing, though. No matter how far the pendulum swung, its movement consumed the same time. Galileo made a note of that. The year was 1581.

The old man sat at his writing desk, sixty years and a thousand disputes later, writing down a new theory. The regularity of a swinging pendulum might be combined with a spring mechanism to improve the unreliable clocks of that day. So Galileo scribbled on, and did nothing more about it. A number of years after his death Huygens took the notes and invented the pendulum clock. *Seventy-seven years had elapsed since the boy made the observation upon which it was based!*

The creative thinker today still need not have a specific use in mind when, by equation or formula, he branches off from the accepted to the hitherto unknown. The classic invention of this decade, the transistor, evolved in the Bell Telephone Laboratories as scientists sought a deeper understanding of semiconductors. On the other hand, another great invention, the feedback amplifier, came from the acutely creative mind of one Bell engineer faced with a specific problem.

Current Bell Laboratories activities—in such areas as data transmission, radar and submarine cable development—call for the coordinated efforts of all types of thinkers and all types of approaches. One type complements another.

Today, seventy-seven years would not have elapsed between the swinging lamp and the swinging clock pendulum—certainly not at Bell Labs, where ideas, though not rushed, are carefully advanced toward fruitful application in national defense, industry and communications. An important part of this harvest is the efficiency of America's telephone service, unequalled anywhere else in the world.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

WE'RE MAKING IT EASIER THAN EVER TO BECOME A WELL PAID
RADIO-TELEVISION SERVICE TECHNICIAN

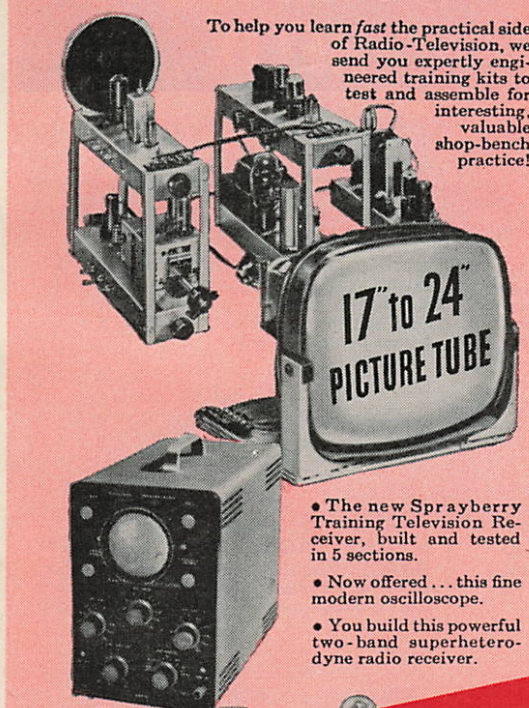
NOW – Just $6 Starts You Training in

RADIO-TELEVISION

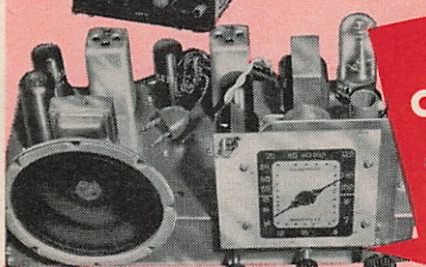
the SPRAYBERRY "Learn-by-Doing" Way . . .

25 BIG, COMPLETE KITS of PARTS & EQUIPMENT

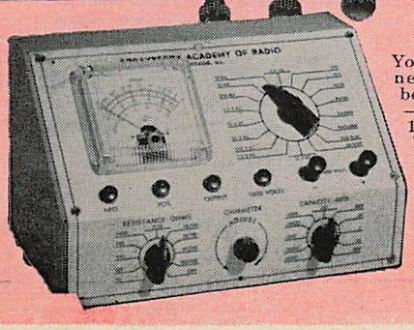
To help you learn *fast* the practical side of Radio-Television, we send you expertly engineered training kits to test and assemble for interesting, valuable shop-bench practice!



- The new Sprayberry Training Television Receiver, built and tested in 5 sections.
- Now offered . . . this fine modern oscilloscope.
- You build this powerful two-band superheterodyne radio receiver.



Big New CATALOG AND Sample Lesson FREE!



You build the new Sprayberry tester—a complete 18-range Volt-Ohm-Milliammeter test meter.

★ ★ ★ ★ This great industry is begging for trained men . . . to step into good paying jobs or a profitable business of their own! Our new plan opens the doors of Radio-Television wide to every ambitious man who is ready to act at once!

Men by the thousands... trained Radio-Television Service Technicians...are needed at once! Perhaps you've thought about entering this interesting, top paying field, but lack of ready money held you back. Now—*just $6 enrolls you* for America's finest, most up to date home study training in Radio-Television! Unbelievable? No, the explanation is simple! We believe Radio-Television *must* have the additional men it needs as quickly as possible. We are willing to do our part by making Sprayberry Training available for less money down and on easier terms than ever before. This is your big opportunity to get the training you need...to step into a fine job or your own Radio-Television Service Business.

Complete Facts Free—Act Now; Offer Limited

Only a limited number of students may be accepted on this liberal and unusual basis. We urge you to act at once...mail the coupon below and get complete details plus our big new catalog and an actual sample lesson—*all free*. No obligation...no salesman will bother you.

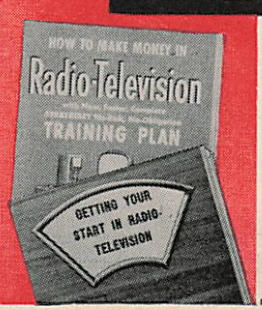
HOME STUDY TRAINING IN SPARE TIME

Under world-famous 27-year old Sprayberry Plan, you learn entirely at home in spare time. You keep on with your present job and income. You train as fast or as slowly as you wish. You get valuable kits of parts and equipment for priceless shop-bench practice. And everything you receive, lessons and equipment alike, is all yours to keep.

LET US PROVE HOW EASILY YOU CAN LEARN!

Radio-Television needs YOU! And Sprayberry is ready to train you on better, easier terms, that any ambitious man can afford. *Just $6 starts you!* Mail coupon today... let the facts speak for themselves. You have everything to gain. Let us prove the kind of opportunity that's in store for you!

SPRAYBERRY Academy of Radio-Television
1512 Jarvis Avenue, Dept. 20-Q, Chicago 26, Illinois



Mail This Coupon Now—No Salesman Will Call

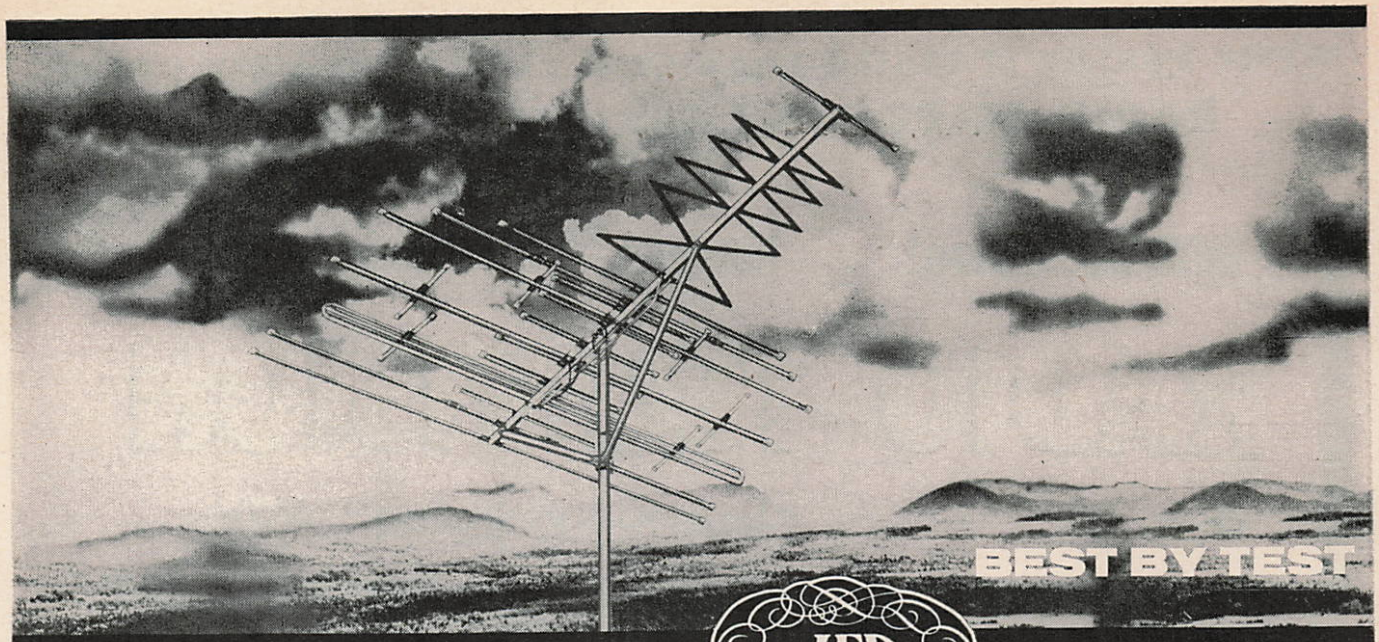
Sprayberry Academy of Radio-Television
Dept. 20-Q, 1512 W. Jarvis Ave., Chicago 26, Ill.

Please rush all information on your ALL-NEW Radio-Television Training Plan. I understand this does not obligate me and that no salesman will call upon me. Include New Catalog and Sample Lesson FREE.

NAME..... Age.....

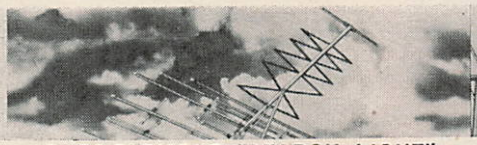
ADDRESS.....

CITY..... ZONE..... STATE.....

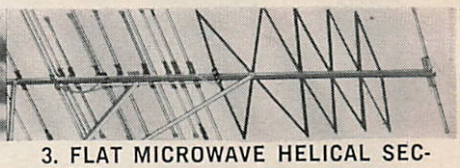


WHAT EVERY SERVICEMAN SHOULD KNOW ABOUT THE JFD Electronics SATELLITE-HELIX

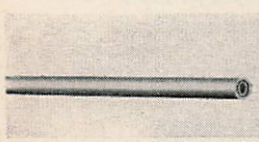
1. BALANCED SLEEVE DIPOLE DESIGN! Shrinks the miles and flattens the mountains. Boosts gain up to 37% over larger fringe antennas. Provides 15 to 1 front-to-back voltage ratio on channels 2 to 6, and 18 to 1 on channels 7 to 13.



2. 28-ELEMENT "SEARCH LIGHT" DIRECTIVITY! Multiple driven dipoles pile up needle-sharp directivity that pinpoints distant stations, sidesteps ghosts and interference for flawless picture definition.



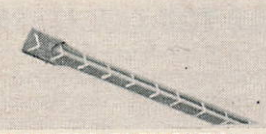
3. FLAT MICROWAVE HELICAL SECTION! Each individual non-linear additive collector is tuned separately for highest gain and sharpest directivity on each of the 7 high band channels.



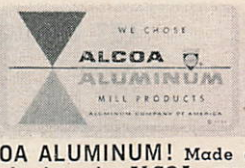
4. 15 INCH ALUMINUM DOWELS! Reinforce all elements over 30 inches in length. Rigidize elements against sag or sway. Keep antenna working and looking like new.

5. DOUBLE U-BOLT FOR DOUBLE-STRENGTH! Grips crossarm powerfully to mast. No shift or slip. Keeps antenna on station beam even in gale-force winds.

6. ONE INCH TUBULAR BOOM BRACE! Full size, full length construction. Rigidizes crossarm, prevents twist or droop. Heavy gauge one inch o.d. aluminum tubing.



7. SEAMLESS ELEMENTS! Six ½ inch diameter seamless elements impart extra strength as well as improve electrical conductivity.



8. ALCOA ALUMINUM! Made of 100% aircraft aluminum by ALCOA—world's top-quality producer—for permanent corrosion-resistance.

9. NATIONALLY ADVERTISED! Dramatic ads all season long in Progressive Farmer, and other national and local TV, radio and newspaper media send ready-to-buy prospects into your store. Plus big co-op advertising allowances.

NOW MORE THAN EVER—It pays to specify a JFD area-engineered Helix Colortenna (with new Balanced Sleeve Dipole design) for every market. **Call or visit your JFD distributor now.**

10. SPECTACULAR INCENTIVES! Yours free! Costly card table and chair sets, hand-painted portraits, aluminum chaise lounge and chair patio sets. No coupon collecting. No contests. Every dealer wins.

11. YOUR HARVEST OF PROFIT! The most dynamic merchandising package ever put to work to nail down bigger and better TV antenna sales for service dealers.

SATELLITE HELIX	POWER HELIX	STAR HELIX	SUPER HELIX	JUNIOR HELIX
Deep fringe	Fringe	Near Fringe	Secondary	Primary

JFD Electronics Corp
6101 Sixteenth Ave Brooklyn 4, New York

JFD International
15 Moore Street
New York, New York

JFD Canada Ltd.
51 McCormack Street
Toronto, Ontario, Canada

UPGRADE YOUR INCOME

through Grantham Training and an F.C.C. License!

What's in Your Future?

Are you *planning* your future or just drifting into it? Now is the time to get ahead in electronics—the world's fastest growing major industry. Now is the time to add technical knowledge and an F.C.C. license to your practical experience. Now is the time to prepare for higher pay—time to make your future secure.

Grantham Training Prepares You

Grantham School of Electronics specializes in quality training in communications electronics, preparing students to pass F.C.C. operator license examinations. This training is available either by correspondence or in resident classes.

The Grantham Communications Course does not include actual work with practical kits or other equipment. That is, for example, it does not teach you how to solder or how to remove a TV chassis from the cabinet, etc. It is not a repair course but, instead, is bona fide technical training which teaches you to understand electronic theory—which teaches you the *"why"* of electronics.

If you are a beginner in this field, the Grantham course will give you the kind of detailed training in radio-electronics theory and operating practices that will enable you to obtain your first class F.C.C. license quickly. Then, this license plus your knowledge of theory will qualify you for certain types of employment, and you can improve your practical ability while on the job earning a salary.

If you already have practical experience in radio-electronics, the Grantham course can add a knowledge of theory and an F.C.C. license to that practical experience. This should qualify you for higher pay and greater job security.

Train by Correspondence or in Resident Classes

RESIDENT CLASSES—The Grantham Communications Electronics Course is offered in both DAY and EVENING classes in Washington, Hollywood, and Seattle. The DAY course meets five days a week, from 9 a.m. until 1 p.m., and prepares you for a *first class* F.C.C. license in 12 weeks. The EVENING course meets two nights a week, from 6:30 p.m. until 10:30 p.m., and prepares you for a first class F.C.C. license in 30 weeks. All courses "begin at the beginning"—NO previous electronics training required or assumed.

CORRESPONDENCE TRAINING—The Grantham Communications Electronics Course is offered by correspondence from all Divisions of the School—Washington, Hollywood, and Seattle. The course has two major objectives—(1) to *teach* you a great deal of electronics, and (2) to prepare you to pass all F.C.C. examinations required for a *first class* license.

This course can prepare you *quickly* to pass F.C.C. examinations because it presents the necessary principles of electronics in a simple "easy-to-grasp" manner. Each new idea is tied in with familiar ideas. Each new principle is presented first in simple, everyday language. Then after you understand the "what and why" of a certain principle, you are taught the technical language associated with that principle. You learn more electronics in less time, because we make the subject easy and interesting.

Which License for Which Job?

The THIRD CLASS radiotelephone license is of value primarily in that it qualifies you to take the second class examination. The scope of authority covered by a third class license is extremely limited.

The SECOND CLASS radiotelephone license qualifies you to install, maintain and operate most all radiotelephone equipment except commercial broadcast station equipment.

THE FIRST CLASS radiotelephone license qualifies you to install, maintain and operate every type of radiotelephone equipment (except amateur) including all radio and television stations in the United States, its territories and possessions. This is the highest class of radiotelephone license available.

Here's Proof . . .

that Grantham students prepare for F.C.C. examinations in a minimum of time. Here is a list of a few of our recent graduates, the class of license they got, and how long it took them:

	License	Weeks
Walter Mengel, Jr., 423 James St., Crystal Lake, Ill.	1st	8
Serge G. Miller, 1315 W. 15th St., San Pedro, Calif.	1st	12
John A. Hayes, 1519 Madison Ave., Memphis, Tenn.	1st	14
Robert A. Morgan, 25 Barrow St., New York, N.Y.	1st	9
Hal Moon, Cook Hotel, 1334 Central, Kansas City, Mo.	2nd	5
W. R. Smith, 1335 E. 8th St., Long Beach, Calif.	1st	12
Erskin D. Davis, 4220 Clay St., NW, Washington, D.C.	1st	12
John R. Bahrs, 72 Hazelton St., Ridgefield Park, N. J.	1st	12
Earl A. Stewart, 3918 Modesto Dr., San Bernardino, Calif.	1st	14
Robert H. Moore, 807 Grace St., Baldwin, L.I., N.Y.	1st	12
Otis A. Towns, 3638 Bates St., St. Louis, Mo.	1st	12

THREE COMPLETE SCHOOLS: *To better serve our many students throughout the entire country, Grantham School of Electronics maintains three complete schools—one in Washington, D.C., one in Hollywood, Calif., and one in Seattle, Wash. All schools offer the same rapid courses in F.C.C. license preparation, either home study or resident classes.*

MAIL COUPON FOR FREE BOOKLET: Our free booklet, *Careers in Electronics*, gives details of how you can prepare quickly for your F.C.C. license. For your free copy of this booklet, clip the coupon below and mail it to the Grantham School nearest you.

GRANTHAM
SCHOOL OF ELECTRONICS

821-19th Street, N.W.	408 Marion Street	1505 N. Western Ave
Washington 6, D. C.	Seattle 4, Wash.	Hollywood 27, Calif.
(Phone: ST 3-3614)	(Phone: MA 2-7227)	(Phone: HO 7-7727)

(Mail in envelope or paste on postal card)

TO: GRANTHAM SCHOOL OF ELECTRONICS

821-19th, NW **Washington** • 408 Marion **Seattle** • 1505 N. Western **Hollywood**

Please mail me your free booklet telling how Grantham training can prepare me quickly for my commercial F. C. C. license. I understand there is no obligation and no salesman will call.

Name _____ Age _____

Address _____

City _____ State _____

I am interested in: ☐ Home Study, ☐ Resident Classes 94 A

Here's the SPECIALIZED

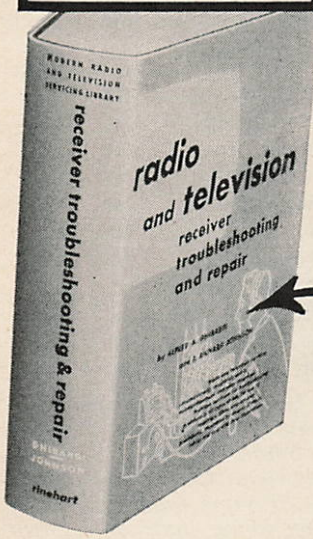
A. A. GHIRARDI

These 2 great Ghirardi books bring you COMPLETE TRAINING FOR MODERN RADIO-TV SERVICING!

SAVE $1.25

Make your service library complete! Get *both* these famous Ghirardi books at a saving of $1.25 under the regular price. See MONEY-SAVING COMBINATION OFFER in coupon.

Let these two famous training books teach you to handle all types of AM, FM and TV service jobs by approved *professional* methods —*and watch your efficiency and earnings soar!* Almost 1500 pages and over 800 clear pictures and diagrams explain EVERY troubleshooting and repair operation as clearly as A-B-C. No needless mathematics. No involved theory. You get straight-from-the-shoulder training of the type that teaches you to do the best work in the shortest time. Each book is co-authored by A. A. Ghirardi whose radio-electronics training guides have, for more than 25 years, been more widely used for military, school and home study training than any other books of their types. Books are sold separately at prices indicated—or you save $1.25 by buying them both. Use coupon or order from Rinehart & Co., Inc., Dept. RE-19, 232 Madison Ave., New York 16, N. Y.



① RADIO & TV CIRCUITRY and OPERATION

Learn about circuits . . and watch service headaches disappear

You can repair ANY radio, TV or other electronic equipment lots easier, faster and better when you're fully familiar with its circuits and know just why and how each one works . . . and that's exactly the kind of specialized training you get in Ghirardi's 669-page Radio & TV CIRCUITRY AND OPERATION training guide. First it gives a complete understanding of basic modern circuits and their variations. Finally it shows what troubles to look for and how to eliminate useless service testing and guesswork. Throughout, it gives you the above-average training that takes the "headaches" out of trouble-shooting—the kind that fits you for the best-paid servicing jobs. Contains 417 clear illustrations.

Sold separately for $6.75—or see MONEY-SAVING COMBINATION OFFER.

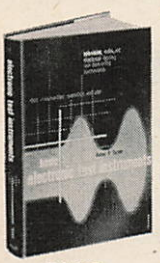
② RADIO & TV TROUBLESHOOTING and REPAIR

Complete training in modern service methods

Radio & TV TROUBLESHOOTING AND REPAIR is a complete 822-page guide to ***professional*** service methods . . . the kind that help you handle jobs faster, more profitably. For beginners, this giant book with its 417 clear illustrations is an easily understood course in locating troubles fast and fixing them ***right.*** For experienced servicemen, it is an ideal way to develop better methods and shortcuts; or to find fast answers to problems. You learn troubleshooting of all types from "static" tests to dynamic signal tracing methods. Step-by-step charts demonstrate exactly what to look for and how to look. A big television section is a down-to-earth guide to all types of TV service procedures. Read it 10 days at our risk!

Sold separately for $7.50 or save $1.25 on MONEY-SAVING COMBINATION OFFER.

Get More Work Out of Fewer Instruments!



BASIC ELECTRONIC TEST INSTRUMENTS
254 pages, 171 illus.
Price $4.95

Save time . . Save money . . Avoid buying instruments you don't really need!

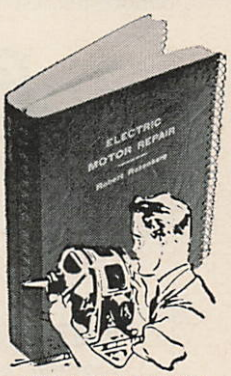
It pays to think twice before you buy new instruments — without first determining whether you really need them — or just how and where you'll actually use them!

BASIC ELECTRONIC TEST INSTRUMENTS is an instrument guide especially for servicemen, amateurs and experimenters. It explains modern instrument types and the advantages and limitations of each. It shows how to choose the instruments you really need; how to understand instrument readings and put them to practical use; how to work with fewer instruments, and how to put old instruments to new uses.

Over 60 instrument types discussed include everything from simple current and voltage meters to ohmmeters and V-O-M's; V-T voltmeters; power meters; impedance meters; capacitor checkers; inductance checkers; special-purpose bridges; oscilloscopes; R-F test oscillators; signal generators; audio test oscillators; R-F and A-F measuring devices; signal tracers; tube testers; grid-dip oscillators; TV sweep and marker generators; square wave generators; distortion meters and many others. It helps you work better—and saves you money.

Check BASIC ELECTRONIC TEST INSTRUMENTS in coupon for 10-day FREE examination

Now! FIX ANY ELECTRIC MOTOR!



TRAIN FOR BETTER PAY IN A FIELD THAT ISN'T CROWDED!

Handle ANY job from minor repairs to complete rewinding

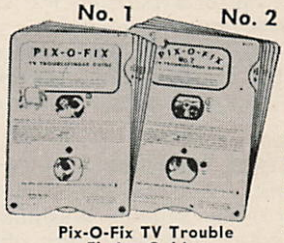
560 pages— Over 900 how-to-do-it pictures

It pays to train for something different! ELECTRIC MOTOR REPAIR is a complete guide that helps you cash in on this vast, rapidly growing field. Shows step by step how to handle all repair jobs (including complete rewinding) on practically ANY AC or DC motor or generator in common use—from fractional horsepower to giant industrial motors. Special duo-spiral binding brings text and related how-to-do-it diagrams side by side so that you learn fast, easily and right. Every job is explained so clearly you can hardly fail to understand it. Over 125,000 copies in use in motor repair shops, schools, and for home study. Fully approved by repair specialists, unions and instructors.

It's the ideal book whether you want to train for a good-pay motor repair job or simply want to fix motors as a sideline or hobby!

Order ELECTRIC MOTOR REPAIR in coupon. Price only $6.95.

SHORT CUT TO TELEVISION REPAIRS



Pix-O-Fix TV Trouble Finder Guides
Only $2 for the two

Eliminate useless testing . . . Fix sets twice as fast

Just turn the dial of the handy, pocket-size Ghirardi & Middleton PIX-O-FIX TV Trouble Finder Guide. When the picture in the PIX-O-FIX window matches the screen image on the television set you're repairing . . . ***presto! . . . you've got your clue.***

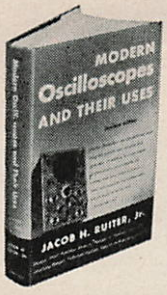
PIX-O-FIX then shows the causes of the trouble. Next it indicates the exact receiver section in which the trouble has probably happened. Then it gives step by step repair instructions.

The two PIX-O-FIX units No. 1 and No. 2 cover 48 different television troubles . . . just about anything you're likely to be called on to fix. No. 1 identifies 24 of the most common troubles and gives 192 causes and 253 remedies for them. No. 2 covers 24 more advanced troubles not included in No. 1. Together, they are a comprehensive guide to quick "picture analysis" servicing of any TV set . . . ***AND THE PRICE IS ONLY $2.00 for the two.*** Money-back guarantee. ***Specify PIX-O-FIX in coupon.***

USE COUPON FOR *10-day Free Trial!*

TRAINING YOU NEED

in its most complete economical and easily understood form



Complete data on getting the most out of the handiest, most versatile instrument of all!

Here's everything you need to know ABOUT OSCILLOSCOPES!

Oscilloscopes are "gold mines" if you learn to use them fully on every job.

THIS BIG BOOK TEACHES YOU HOW!

Here, in a big, revised 2nd edition, is THE book that really shows you how to get more work out of your oscilloscope.

Clearly as A-B-C MODERN OSCILLOSCOPES AND THEIR USES gets right down to "brass tacks" in telling you exactly when, where and how. You learn to locate either AM or FM radio or television troubles in a jiffy. Even tough realignment jobs are made easy. No involved mathematics! Every detail is clearly explained—from making connections to adjusting circuit components and setting the oscilloscope controls. And you learn to analyze patterns fast and RIGHT!

Includes latest data on quantitative measurements (the slickest method of diagnosing many color TV troubles and aligning sets properly); using 'scopes in industrial electronics, teaching . . . even in atomic energy work. Over 400 helpful pictures including dozens of pattern photos make things doubly clear. Price $6.50.

Oscilloscope experts get the BIG PAY jobs!

Practice 10 days free. Order MODERN OSCILLOSCOPES in coupon.

Cash in on HIGH-FI SERVICE and BUILDING

HIGH FIDELITY TECHNIQUES
By John H. Newitt
494 pages, 203 illus.
Price $7.50

A complete guide to better High Fidelity methods and results

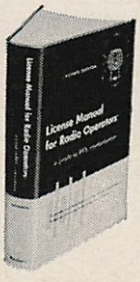
Get better results from "Hi-Fi" by having all the facts and latest ideas at your fingertips!

This big book brings you complete data on modern sound reproduction methods and equipment. It shows how to get better results at lower cost; how to build your own; how to service hi-fi equipment; discusses all details of components; compares different methods — AND IS CRAMMED FULL OF HOW-TO-DO-IT TIPS AND IDEAS.

Here are just a few of the many subjects! How to get the right hi-fi equipment for your needs; Hi-fi versus P.A. type speaker; Loudspeaker construction and performance; Adjusting bass-reflex cabinets; Controlling distortion; Getting rid of "hangover"; Selecting a woofer-tweeter; Sound-proofing materials; All about output transformers; Special hi-fi circuits; Ways to suppress noise; Negative feedback and how to use it; Amplifier construction hints; Minimizing tuner distortion; Avoiding chatter; Limiter-discriminator vs. ratio detector FM circuits; Avoiding record wear; Tips for custom builders; Bass-reflex charts; Acoustical horn design data; special installation problems; pre-amps and equalizers; pickup resonance; a novel horn system . . . and dozens of other subjects.

Order High Fidelity Techniques in coupon today for 10-day FREE trial!

HOW TO GET YOUR TICKET in a jiffy!



LICENSE MANUAL for Radio Operators

by J. R. Johnson (W2BDL)

A complete, practical study guide for getting your "ticket" as a well paid commercial operator.

Cash in on radio where the pay is best!

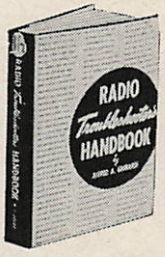
Get one of radio's best paying jobs—as a commercial operator aboard ship, in aviation, in broadcasting or telecasting and the many other places where an FCC license is a "must"!

LICENSE MANUAL FOR RADIO OPERATORS by J. R. Johnson is a quick, low-cost guide to help you breeze through FCC exams. Written so you can easily understand and remember it. Covers ALL EIGHT exam elements—not just some of them. Reviews almost 2200 typical questions. Gives straight-to-the-point answers. Includes the changes in exam elements 1 and 2. Covers all data from electrical and radio fundamentals to navigation and related subjects.

JOB OPPORTUNITY NEWS! Under a new ruling, only holders of 1st or 2nd class radio-phone licenses can do any work that affects the broadcasting of a transmitter. This is just one of many good job opportunities open to license holders!

Check LICENSE MANUAL FOR RADIO OPERATORS in coupon. Price only $5.00

DON'T THROW OLD RADIOS AWAY!



Covers every model made by 202 mfrs. from 1925 to 1942

Here's the data you need to fix old sets in a jiffy!

Just look up the how-to-do-it data on that troublesome old radio you want to fix.

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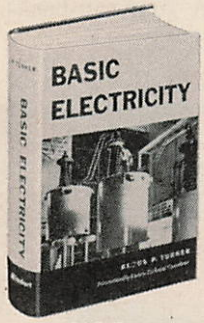

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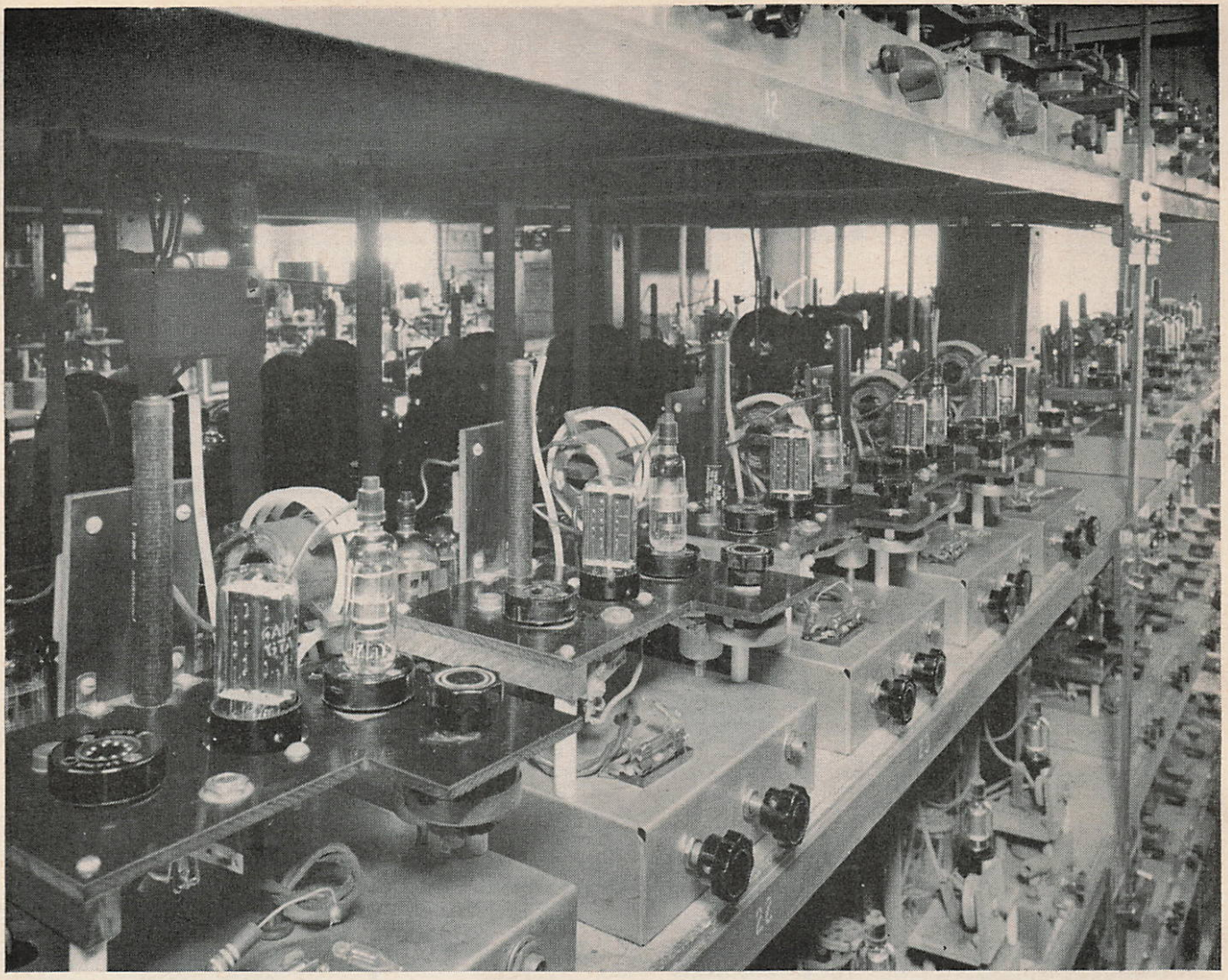

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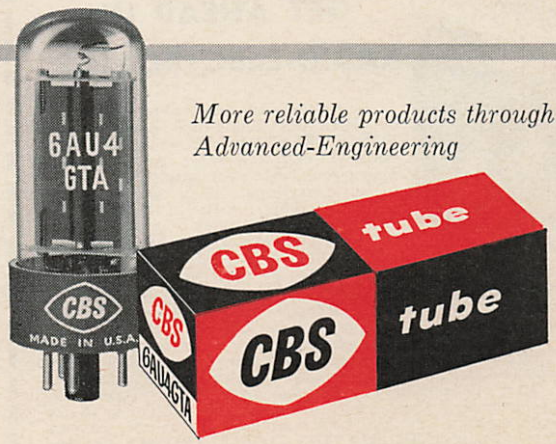

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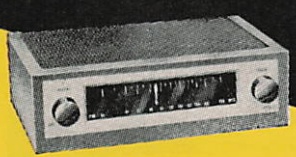
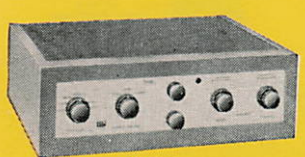
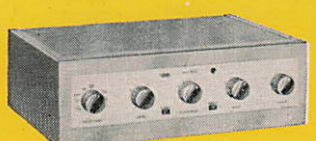
Stereo Preamplifier HF85


FM Tuner HFT90


Stereo Amplifier-Preamp HF81

Bookshelf Speaker System HFS1


Monaural Integrated Amplifiers: 50, 30, 20, and 12-Watt (use 2 for Stereo)

Speaker System HFS2 36" H x 15¼" W x 11½" D

Monaural Power Amplifiers: 60, 50, 35, 30, 22 and 14-Watt (use 2 for Stereo)

Monaural Preamplifiers: HF65, HF61 (stack 2 for Stereo)

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HF81: Stereo Dual Amplifier-Preamplifier selects, amplifies & controls any stereo source—tape, discs, broadcasts—& feeds it thru self-contained dual 14W amplifiers to a pair of speakers. Monophonically: 28 watts for your speakers; complete stereo preamp. Ganged level controls, separate focus (balance) control, independent full-range bass & treble controls for each channel. Identical Williamson-type, push-pull EL84 power amplifiers, excellent output transformers. "Service Selector" switch permits one preamp-control section to drive the internal power amplifiers while other preamp-control section is left free to drive your existing external amplifier. Kit **$69.95.** Wired **$109.95.** Incl. cover.

MONAURAL PREAMPLIFIERS (stack 2 for Stereo)

NEW HF65: superb new design, Inputs for tape head, microphone, mag-phono cartridge & hi-level sources. IM distortion 0.04% @ 2V out. Attractive "low silhouette" design. **HF65A** Kit **$29.95,** Wired **$44.95. HF65** (with power supply) Kit **$33.95.** Wired **$49.95.**

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HF20: 20-Watt Integrated Amplifier. "Well-engineered" — Stocklin, RADIO TV NEWS. Kit **$49.95.** Wired **$79.95.** Cover E-1 $4.50.

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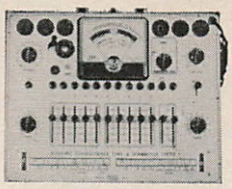

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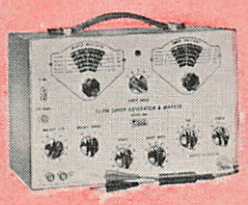
KIT $69.95 WIRED $109.95

COMPLETE with steel cover and handle.

SPEED, ease, unexcelled accuracy & thoroughness. **Tests all receiving tubes** (and picture tubes with adapter). **Composite indication of** Gm, Gp & peak emission. **Simultaneous sel** of any 1 of 4 combinations of 3 plate voltages, 3 screen voltages, 3 ranges of continuously variable grid voltage (with 5% accurate pot). **New series-string voltages:** for 600, 450, 300 ma types. **Sensitive** 200 ua meter. **5 ranges meter sensitivity** (1% shunts & 5% pot). **10 SIX-position lever switches:** freepoint connection of each tube pin. **10 pushbuttons: rapid** insert of any tube element in leakage test circuit & speedy sel. of individual sections of multi-section tubes in merit tests. **Direct-reading** of inter-element leakage **in ohms. New gear-driven rollchart. Checks n-p-n & p-n-p transistors:** separate meter readings of **collector leakage current & Beta** using internal dc power supply. Deep-etched satin aluminum panel; rugged grey wrinkle steel cabinet. **CRA Adapter $4.50**



NEW! TV-FM SWEEP GENERATOR & MARKER #368

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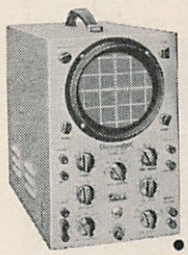
Entirely electronic sweep circuit (no mechanical devices) with accurately-biased **inereductor** for excellent linearity. **Extremely flat** RF output: **new AGC circuit** automatically adjusts osc. for max. output on each band with min. ampl. variations. **Exceptional tuning accuracy:** edge-lit hairlines **eliminate** parallax. **Swept Osc. Range 3-216 mc in 5 fund. bands. Variable Marker Range 2-75 mc in 3 fund. bands;** 60-225 mc on harmonic band. **4.5 mc Xtal Marker Osc., xtal supplied.** Ext. Marker provision. Sweep Width 0-3 mc lowest max. deviation to 0-30 mc highest max. dev. 2-way blanking. Narrow range phasing. Attenuators: Marker Size, RF Fine, RF Coarse (4-step decade). Cables: output, 'scope horiz., 'scope vertical. Deep-etched satin aluminum panel; rugged grey wrinkle steel cabinet.



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• **Features DC Amplifiers!**

Flat from DC-4.5 mc, usable to 10 mc. **VERT. AMPL.:** sens. 25 rms mv/in; input Z 3 megs; direct-coupled & push-pull **thruout;** K-follower coupling bet. stages; 4-step freq-compensated attenuator up to 1000:1. **SWEEP:** perfectly linear 10 cps-100 kc (ext. cap. for range to 1 cps); **preset TV V & H positions;** auto. sync. ampl. & lim. **PLUS:** direct or cap. coupling; bal. or unbal. inputs; edge-lit engraved lucite screen; dimmer; filter; bezel fits std photo equipt. High intensity trace CRT. 0.06 usec rise time. Push-pull hor. ampl., flat to 400 kc, sens. 0.6 rms mv/in. Built-in volt. calib. Z-axis mod. Sawtooth & 60 cps outputs. Astig. control. Retrace blanking. Phasing control.

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Series/Parallel **R-C COMBINATION BOX #1140**

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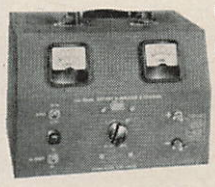
TUBE TESTER #625

KIT $34.95 Wired $49.95

- tests 600 mil series string type tubes
- illuminated roll-chart

Pix Tube Test Adapter $4.50



6V & 12V BATTERY ELIMINATOR & CHARGER #1050

KIT $29.95 WIRED $38.95

Extra-filtered for transistor equipt. #1060 KIT $38.95 WIRED $47.95

New!

Miniaturized **MULTI-SIGNAL TRACER #145A**

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20,000 Ohms/Volt V-O-M #565

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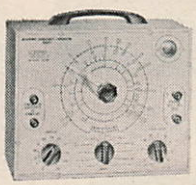

Reads 0.5 ohms −500 megs, 10 mmfd−5000 mfd, power factor.

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Radio-Electronics
Hugo Gernsback, Editor

STORED TELEVISION RECEPTION

... Television Receivers' Next Great Advance—Home Recorders ...

THE next great advance in home television receivers will no doubt be *stored or recordtelevision.* The year 1958 has seen an important breakthrough in magnetically taped-recorded programs. Now used by many of our television broadcast stations, tape recording enables them to record any program for later rebroadcasting. It took many years to develop this important new advance, but the cost of recording such television broadcasts on magnetic tape is fantastically high. The necessary equipment costs over $45,000. Obviously, only well financed stations can afford it. The tape on which the program is recorded is expensive, too, because an hour's recording runs into no less than 4,500 feet of 2-inch-wide tape. In addition, the video track is recorded on the tape *laterally*—from side to side—by four recording heads which revolve at the unusually high speed of 14,400 revolutions per minute. In a single second they make a recorded track of 320 feet. In 1 hour the 10-mil-wide track would be 207 miles long! For these reasons, home-television recording at the moment, for economic reasons, is only a dream.

Yet all engineers, as well as the public, agree that home-recorded television reception is a *must* for the future, for many reasons. We are not always home to view an important program. Or we may be otherwise occupied, or it is not convenient to view it. Or there may be two or more other important programs on, which we cannot possibly view at the same time. Or one person wishes to see one program while another desires a different one.

What is the answer? It is plain that present-day recording technique is out of the question for home television. We can neither use rotating disks, which would have to be 10 or 12 feet in diameter to record a single TV program, nor expensive magnetic tape by the mile. And these—outside of the even more costly photographic film—are about all the technical means at our disposal today when it comes to recording.

It will be noted further that in ALL present-day recording, we always use mechanical means—*something speeds past a given recording point.* It also must move mechanically at a certain speed *in time.*

Yet there are other means which have been in use for hundreds of millions of years. We may call them electronic, although in reality they are electro-chemical-biologic. Nevertheless, they work perfectly; neither are they mechanical, nor does anything "move" in the strict definition of that term. Let us take an example: you have a long vivid dream. You wake up and for half an hour you tell your wife all about that dream and all the hundreds of various experiences that you had, what you saw, what was said, etc. Or you see a good movie. Weeks or months later you can at will recall all the visual impressions, practically every scene; you can also recall the faces of the actors, as well as their talk.

All this—and millions of other impressions, ever since you were a few years old—is recorded almost indelibly in the memory part of your brain, ready to be "played back" at an instant. No cumbersome machinery here, nothing that "moves" mechanically. The microscopic nerve ends and the *neurons* of your brain do the recording. Scientists believe that all such recording is effected by electrochemical means and that the recall—the "playback"—is by similar means. While we stand in awe of these, to us, miraculous biological wonders, it is certain that scientists sooner or later will hit on the counterpart of our memory mechanics.

Indeed, we have made an excellent beginning in this direction. Electronic engineers have already designed the very intricate magnetic memories now in use in electronic computers—the so-called electronic brains. Certain of these magnetic memories are fashioned of thin wire screening. Wherever wires cross, there is a tiny magnet—a small ferrite ring locked around the intersection. Such an assembly a few inches square can store myriads of bits of information which the computer scans electronically, when it wishes to recall certain information. In this respect it works amazingly like its counterpart: the human brain.

From such a beginning we may be certain that in the not-too-distant future it will be possible to evolve purely electronic means of storing television home programs.

Can we *store* electrical impulses electronically, *non-mechanically,* without moving tapes or revolving disks? I think so. You can, for instance, charge a large-capacitance capacitor with a weak continuous electrical current, then discharge it slowly. You can also store electricity electrochemically in a storage battery, and much later withdraw its electrical energy over a certain length of time. Here, too, nothing moves mechanically.

Better yet—as an analogy—you can send television impulses to the planet Mars at its nearest opposition, 35 million miles. They take 3 minutes 10 seconds to reach Mars. The signals now bounce back in another 3 minutes 10 seconds. Hence, you "stored" the signals for over 3 minutes. Nothing moved mechanically. (Memories that work on the same principle are used in some computers.)

I can imagine a future, very sophisticated electronic memory, perhaps a combination magnetic memory integrated with an *electret.* (The latter is a permanently polarized piece of dielectric material and is a direct counterpart or analog of a magnet.)*

With such a combination (or a similar one), I believe a simplified method of home television recording can be produced in due time.

As the impulses of the television picture come in, *they must be recorded and stored successively in time.* If this were not done, all impulses would be piled on top of each other; remember, *nothing moves in this future electronic memory.* (Present-day computer memories record on moving drums.) Thus, in our future electronic-delayer memory, it is possible to *record in time.* When we wish to play back the television recording, we have only to flip a switch which turns on the electric current. The electronic-delayer memory—EDM for short—will then faithfully reproduce the program.

As with all present recorders, the EDM will play back the recording as often as desired. If a new recording is wanted, the old one will be electronically erased, as magnetic tapes now are.

Undoubtedly, the first EDM's will be expensive. But when mass-produced, the price should be within reason. If the device is finally perfected, I am certain that every television set will have an electronic-delayer memory built into it as a necessary accessory.

Obviously, too, all receivers will have to be equipped with special clocks that can be set to record a number of programs as much as a week ahead. These programs can then be released at a desired later date. —*H.G.*

* See RADIO-ELECTRONICS for electret information, " 'Frozen' Electricity, the Electret," *Radio-Craft,* November, 1945; "Electret Construction," *Radio-Craft,* May, 1948; "Improved Electrets," RADIO-ELECTRONICS, April, 1949; "Electret Behavior," RADIO-ELECTRONICS, May, 1949.

HIGHWAY SAFETY ..Challenge to Electronics

Spurred by rising slaughter on highways, the electronic and automotive industries have been given the green light to eliminate the factor of human error through electronics—and to proceed full speed toward automatic highways and self-driving cars

By DAVID LACHENBRUCH
ASSOCIATE EDITOR

THE sign at the roadside has one word on it: **"Automatic."** You relax your grip on the steering wheel, and as you feel the automatic control take over, you release it entirely.

You swivel the driver's seat until you're facing the TV set, and you lean back and prepare to be entertained—while your car neatly maneuvers the cloverleaf approach to the expressway.

By the time you've found a program worth watching, your car has slowed to about 10 miles an hour to pass through the unmanned scanning booth, which makes a quick remote check of the electronic and mechanical equipment of your vehicle and jots down your license number for your toll-highway bill at the end of the month. (Of course, if your credit's no good, they'll put the bite on you at the exit.)

While you watch TV, eat lunch or doze, you traverse the automatic highway at a steady speed, passing the few slower vehicles and slowing down at trouble spots. It's a safe, sunny day, so the autodrive sticks to the 80-mile-an-hour speed limit.

Suddenly you're startled out of your reverie by an insistent beeping tone. You swivel your seat to manual-drive position and prepare to take over.

After the exit scanning booth, you grip the wheel, although you know the autodrive will be on until you have reached the end of the cloverleaf interchange. You pass the parking plaza where a score of cars have been neatly and automatically beached until their drivers regain sufficient alertness for the chore of manual driving.

How far-fetched is it?

This science-fictionesque version of a Sunday drive is based on research and development already well under way by some of the top electronic and automotive companies. Their engineers won't even speculate when you might be able to take such a drive—but they agree that the day must come, and the sooner the better.

Now let's take another hypothetical Sunday drive—one which uses electronic controls to a more limited extent.

Heeding the call of the open road, you load the family into the car and head for the countryside. But first, there's Main Street to be crossed—and, of course, the traffic light is red. As your car passes under an overhead radar sampler, a pulse is sent to a central computer which is continually measuring traffic flow and controlling light-change cycles at major intersections.

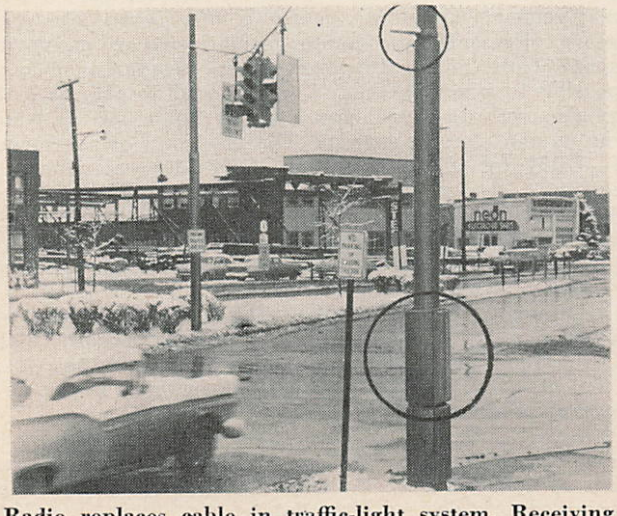
The green light flashes on and you release the brake. But without warning you get the red light again. Then you hear a siren and a fire engine roars past the intersection—its radio signals changing each traffic light to red for a distance of a block ahead.

Finally you head for open country. To get information on road conditions, you turn on the electronic congestion warning system. A few twists of the knob and you hear the traffic bulletin: "Route 78 is overcrowded, traffic moving slowly." You revise your plans and head for the toll superhighway.

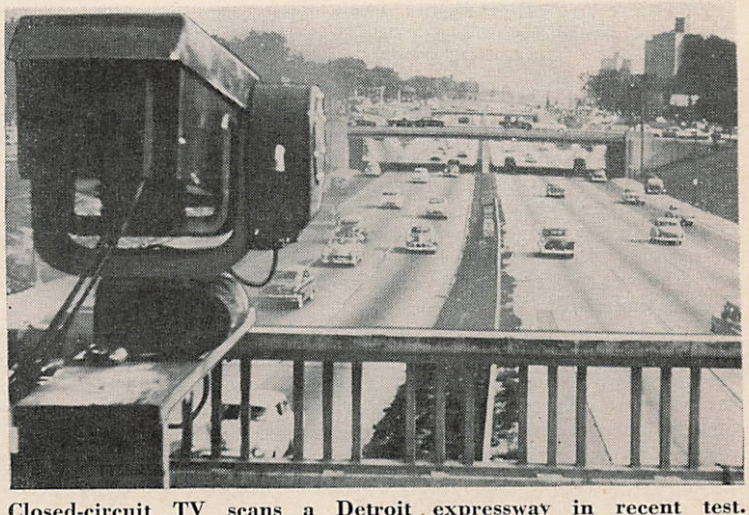
You enter the "correct change lane" at the toll booth, dropping your coins into a receptacle. Your money is electronically counted and the signal changes from red to green.

Once on the superhighway, your car is surveyed by closed-circut TV cameras mounted on overpasses while a traffic specialist in a distant control room watches a bank of TV monitors for possible tie-ups. You pass a sign which says "Highway Patrolled by Radar" and subconsciously you let up a little on the accelerator.

Soon it's early evening and you're heading home. The photocell-activated



Radio replaces cable in traffic-light system. Receiving antenna (upper circle) is cut to 450-mc carrier frequency. Tone translator (lower circle) responds to combinations of audio tones, keying signal-change cycles.



Closed-circuit TV scans a Detroit expressway in recent test. A more extensive experiment is planned, using 33 cameras to patrol an eight-mile stretch. Roadside warning and detour signs will be activated from a central control room.

highway lights flick on and you turn on your headlights, kicking the footswitch to be sure the electronic headlight dimmer is in action.

Finally home, you wait wearily while the garage-door opener responds to the transmitter in your car.

A Sunday drive of the future? Not at all. All of the electronic devices mentioned are in use now on the streets and highways of America. (For the sake of giving this little excursion a happy ending, one of them—two-way police radio—was left unmentioned.)

Preview of coming attractions

Simple as today's highway electronic devices may be, they are the forerunners of systems which eventually will lead to auto automation.

The radar-actuated traffic light system will lead to a whole array of electronic intersection controls which will stop and start your car automatically at busy corners. The fire engine's radio transmitter some day will control the actions of nearby automobiles.

The only piece of electronic equipment currently in most automobiles—the radio—will become an important part of the electronic safety system. Special transmitters along the roadway or carried by traffic policemen will relay warnings and verbal instructions directly to the driver, through his radio, whether it's turned off or on.

The electronic coin counter is an early step toward the automatic toll booth and safety inspection station. Closed-circuit TV installations on superhighways will lead to full-scale traffic surveillance systems which adjust the speed and routing of traffic to road and congestion conditions.

The police radar is a precursor of a whole complex of remotely controlled traffic violation detectors. The electronic headlight dimmer actually is the first detection–warning–control mechanism inside the car itself.

The "compatible" approach

Compared to many other fields, today's use of electronics in auto safety is crude and elementary. Yet the very factor which makes electronic safety measures so necessary is also the biggest barrier to their development and use—the tremendous number of cars on the road and the astronomical amount of highway miles in the United States. Since an automated traffic system will require equipment both in the car and on the road, it obviously isn't an overnight proposition.

Most traffic engineers agree on the three-step "compatible" approach to electronic driving devices. The first step is the installation of electronic warning devices in the highway, with roadside "indicators," which may be used to warn and inform drivers of cars which have no electronic control equipment in them.

The second step is to move the "indicators" into the car—in other words, new audible and visual warning and information instruments within the car would be activated from electronic equipment in the road.

The third stage would be automatic control—cars equipped with small computers and servos would be driven automatically in response to the same signals which activate the roadside and within-the-car indicators. In this way, the nonequipped, partially equipped and the completely equipped cars could be "instructed" by the same highway electronic system.

Don't get the idea that the automatic highway is only a dream. Under a grant from the AAA Foundation for Traffic Safety, the nation's top traffic and highway officials were brought together with engineers from leading electronics companies in a recent meeting. The purpose: to get automatic electronic devices off the drawing board and onto the road.

The traffic officials told the electronics industry, in effect: "We want foolproof electronic safety equipment and we want it in a hurry." A permanent organization was established to get automatic and semi-automatic highway systems into full-scale testing as soon as possible.

Highway tests conducted

One automatic system has already had some practical testing under highway conditions. This is the much publicized RCA system, under development for many years by a laboratory team working under famed RCA honorary vice president Dr. Vladimir Zworykin in cooperation with the General Motors Research Lab.

All three stages of this compatible system have been demonstrated by RCA and GM. It requires the installation of rf-carrying cables and loops under the road.

An installation was made in a 400-foot curved strip of new public highway near Lincoln, Neb., last year. A car equipped with special indicators was driven over the strip with its windshield covered; at the same time, conventional nonequipped cars were warned by lights along the road.

Using either the instruments within the special car or the lights along the highway, the drivers of cars on this stretch were informed electronically whether they were following another vehicle too closely, whether there was an obstacle on the road ahead, and at the same time were accurately guided along the traffic lane.

A modified version of this system is permanently installed in the entrance roadway of RCA's Princeton, N. J., laboratories. This one is strictly a speed analyzer which activates an electric warning sign when drivers exceed the speed limit.

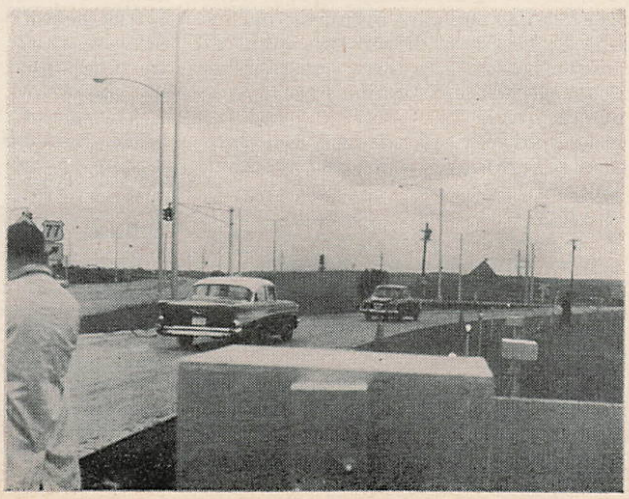
While RCA works on equipment for electronic highways, General Motors is developing gizmos for automatic operation of the car itself. A mile-long test road at GM's Technical Center in Warren, Mich., is equipped with a buried guidance cable similar to the one installed in Nebraska, and a 1958 Chevrolet has been rigged up with a relatively simple glove-compartment computer and servo mechanism which completely takes over the steering function. GM hasn't yet demonstrated other features of the RCA system, such as automatic braking and maintenance of distance between cars.

Much more imminent than the automatic highway are anti-collision proximity devices installed in the car itself—"vehicular radar." Lots of progress has been made in this field in the last few years, and you may be able to select radar as an "option" with your next car. It should be available within the next five years.

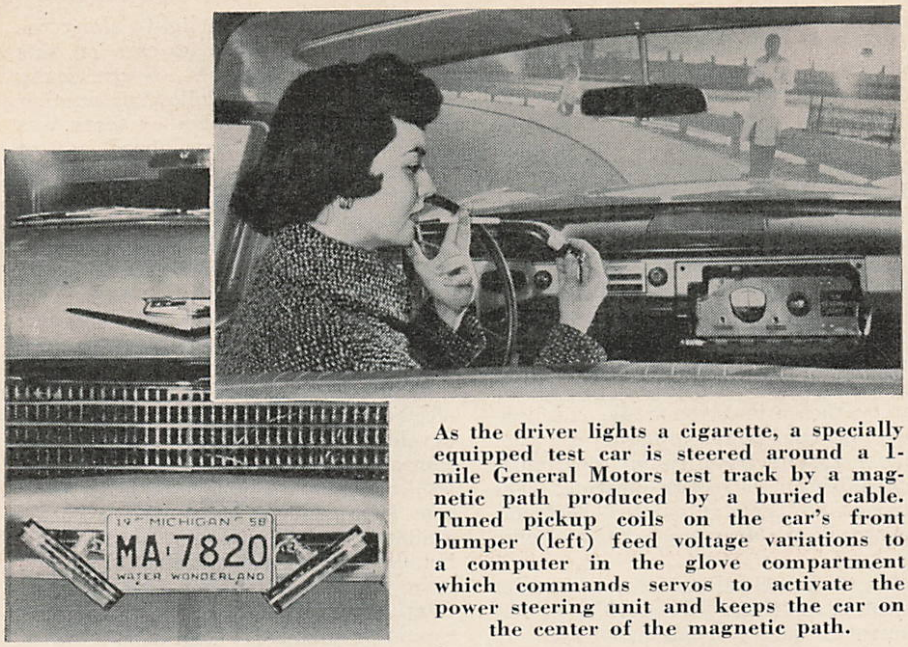
At least two such systems have been extensively field-tested. General Motors, which has installed a "prox" system on one of its "cars of the future", is understood to be making production plans for it. Bendix Aviation Corp. has a production-ready radar system which it is now trying to sell to auto manufacturers.

Both systems will be described in a subsequent article in this series.

The idea of self-steering and radar-equipped cars isn't new, of course. A patent was issued in 1937 to A. W. Braun for an electronically controlled highway system in which cars would straddle a white line painted on the



Semi-automatic control system is demonstrated near Lincoln, Neb. Buried cables and loops detect and respond to passage of vehicles. Roadside lamps light as each car passes over detector loops. Special receiver in the test car (left) picks up warning signals generated by car ahead. Unequipped cars use roadside lights as guide to obstacles ahead or around curves.



As the driver lights a cigarette, a specially equipped test car is steered around a 1-mile General Motors test track by a magnetic path produced by a buried cable. Tuned pickup coils on the car's front bumper (left) feed voltage variations to a computer in the glove compartment which commands servos to activate the power steering unit and keeps the car on the center of the magnetic path.

highway (instead of a radiating cable) and keep on course with bumper mounted photocells which would actuate an automatic steering system similar to that used by RCA and GM. In 1947, Hugo Gernsback wrote in his annual Christmas booklet of an "electronic robot-steered car," elaborating on this white-line guidance system and incorporating radar to apply the brakes automatically when approaching within 50 feet of the car ahead.

What is new is the exhaustive research and testing now underway by large electronic and automotive firms to transform the idea of the automatic highway into a reality. Field-testing of new and as yet unpublicized electronic auto safety devices is in progress.

Wanted: more information

What will these devices do? The best bet is that they'll be designed to keep drivers better informed of what's going on in and around the car.

When you're at the wheel of your V8, you simply don't have enough information to be a safe driver. So says Minnesota state traffic engineer J. E. Darrell. One reason for the fantastically high accident toll, he says, is that we're driving our cars by guess and by gosh. To be a safe driver, you ought to know the answers to these questions at all times, without taking your eyes from the road:

- Is your car operating speed safe for the highway, traffic and weather conditions?
- Are you within the speed limit?
- Do you have enough gas to reach the next filling station?
- Are there any cars approaching you from the rear or at an angle?
- Can you safely pass that car ahead?
- If you pass the bunched-up group of cars ahead of you, will you find open road ahead?
- What's over that hill or around that curve?
- Are you falling asleep?
- How often is this highway patrolled in case of a breakdown?
- Are there excessive carbon monoxide fumes in the car?

How to give you this dashboard encyclopedia is only part of the challenge the highway engineers have flung at the electronics industry—the first part, the "nonautomatic" part.

Or, as another expert—Houston, Tex., traffic director Eugene Maier—put it, your car should be equipped with these lifesaving gadgets the sooner the better, long before you get to take that ride on the automatic highway:

- A device which moves the traffic lights into your car, telling you that you're coming to an intersection and you'll have to stop—or else that you'll be able to clear it without stopping.
- Another one which will tell you when a car is approaching from a cross street.
- A gadget that will warn you that you're in the wrong lane or too close to the edge of the road.

He also wants to equip traffic cops with short-range radio transmitters to relay instructions directly to you via your car radio.

And pedestrians would carry or wear devices which transmit some kind of warning signal to tell you they're crossing the street.

Any one of these systems lends itself to the compatible approach—an information system first and later an automatic car-driving system.

Outside the car

Long before automatic cars travel automatic highways, we can begin automating our superhighways to make them safe. A New Jersey Tunrpike traffic engineer wants his heavily traveled superhighway to have these automatic devices soon:

- Warning signs which can be changed from a remote control point to indicate speed limits, detours, weather or congestion conditions. Such a system, coupled with closed-circuit TV traffic monitors, is now being installed on a Detroit expressway.
- A remote "congestion detector," which would spot traffic tie-ups and automatically report them to the control room.
- A remote speed and traffic recorder.
- An automatic "unsafe car detector" which would inspect tires, lights and brakes as cars pass through the toll gate, and automatically bar unsafe ones from the turnpike.

What the police want

And then there are the police. They want the long arm of the law to reach right into your car-of-the-future.

They've proposed some gadgets which smack of "Big Brother" snooping. Though they're all within the realm of electronic possibility, it's doubtful whether the public would stand for some of them.

Most involve some type of recorder locked into the car to keep a record of the driver's transgressions. Bus and truck lines now use speed recorders which keep permanent records, and the proposed devices would elaborate on this technique and extend it to the passenger car.

One proposal is a "speed monitor." Here's how it might be used:

You hear the ominous sound of a police siren and pull over to the curb.

"Okay, buddy," says the cop. "Let's see your speed monitor."

You sheepishly remove a continuous loop of magnetic tape from a dash compartment. The officer takes it to his car and plays it back, reading your exact speeds of the last five minutes on his own speedometer.

Another version of this device incorporates a mother-in-law effect which "initiates a persistent raucous sound" to warn you that it's recording a speed violation.

A third proposed monitor would be encased in a sealed cartridge and keep a permanent record of traffic violations —such as crossing a "no-passing" line. This would be inspected yearly by the police.

While it's unlikely that you will ever have one of these electronic stool-pigeons in your own car, there's little doubt that devices planted along the roadway will some day be able to detect law violations just as efficiently.

Electronic safety systems in use today and some of them being engineered for tomorrow will be examined in detail in subsequent articles.

In the meantime, New York City Traffic Commissioner T. T. Wiley throws out this challenge to America's electronic inventors, professional and amateur:

"The one device that would probably eliminate more fatal accidents than all other devices combined would be one to prevent the engine from running whenever a person under the influence of alcohol is at the wheel."

Got any ideas? END

Computers Speed Aircraft Design

It's a long way between the drawing board and the flight test. Both analog and digital computers save steps along the way

By FORREST H. FRANTZ, SR.

BOTH modern aircraft and guided missiles are highly complex. The aircraft's shape must allow best aerodynamic performance and at the same time the utmost in structural strength. Controls must be designed so the aircraft can be handled easily and safely. Fire control must make the best use of the plane's armament. The pilot's environmental needs must be met, as must those of the equipment. The guidance and control requirements of guided missiles make their design problems even more complex.

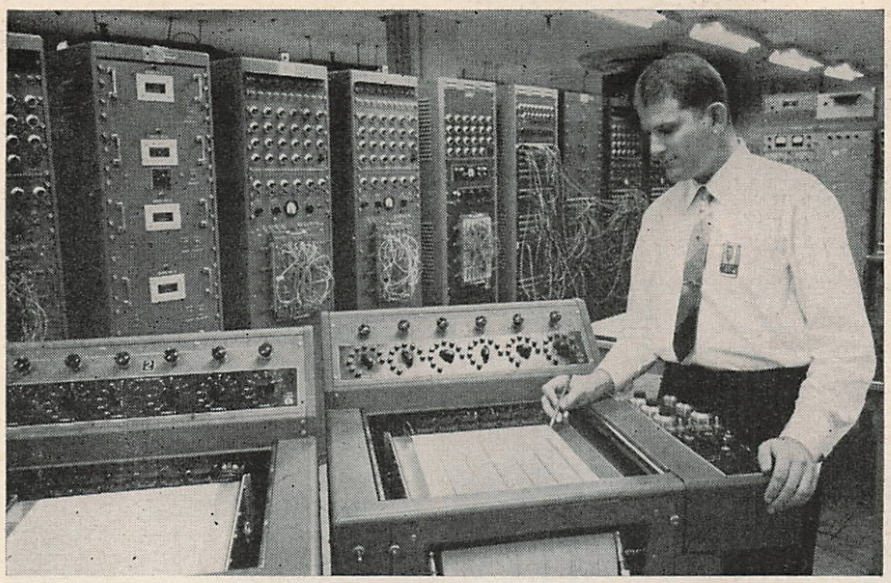
These are a few of the general design problems—there are many more. And within each of these general problems are many specific ones. Many of them are solved on paper before the first model is built. But design problems are complicated by many interacting facets, and all cannot be solved so simply. Some of those that can be solved on paper are not always completely solved because unpredictable factors or human error may lead to incomplete solutions. So in every phase of the paper design, computers are put to work.

The problems which do not lend themselves to complete solution are fair prey for computers, too. Instead of building the first aircraft from a paper design and then modifying it as necessary, there has been an increasing trend to precheck concepts by simulating parts of the aircraft system with a computer. This approach saves time, manpower and dollars. When the aircraft is built, the designers are surer that it will perform properly.

Computers play two parts

There are two basic approaches to using computers in aircraft design. They may be used to compute or to simulate. If a number of the parameters in a problem are known, the problem may be solved by computing the value of the unknown. Unfortunately, the problems in aircraft design are not this simple. Too many unknown intimately related quantities rear their ugly heads. To cope with these problems, aircraft designers usually resort to complicated mathematics. Sometimes, computations are repeated with the quantities in a problem varied slightly each time to determine the best values. Large-scale digital computers handle these jobs readily.

Simulation calls for imitating a system. The imitation may be an exact part-for-part duplicate of the anticipated system. But it's much less expensive and quicker to use a computer to imitate all or part of the system. A capacitor, coil and resistor can simulate a spring–mass–friction mechanical combination (see Fig. 1). It's even easier to simulate the mechanical combination with an analog computer



Many problems associated with aircraft design and performance evaluation are solved by the analog computer division of Chance Vought Aircraft.

because the values of spring, mass and friction constants are easier to select. If the equations which describe the motion of an aircraft and the aircraft's response to pilot control motion are set up on a computer, the designers can "fly" their aircraft before it is built!

As the design progresses, the design problem breaks down into many specific problems that simulating helps solve. As an example of how simulation is used at this design level, consider the aircraft control surfaces actuated from the cockpit. The block diagram of such an electrical hydraulic-control system is shown in Fig. 2.

The stick in the cockpit is attached to an electrical transducer which changes mechanical motion to an electrical signal. This signal is transmitted to hydraulic control valves which actuate control surfaces. The system must provide the right ratio of control to each surface. It must also keep the rate of control and the total range of control within safe limits. Servomechanism, electronic and hydraulic techniques are involved. But all are intimately related with the control-valve characteristics.

A cockpit simulator with actual electrical controls and an analog computer which duplicates the performance of the hydraulic control surface actuators can represent the system. Valve characteristics may be changed readily with analog computer potentiometers. The results of the simulation are used to design the control valves.

Cockpit instruments must tell the pilot everything he needs to know and the cockpit controls must allow the pilot to tell the aircraft exactly what he wants it to do. If the placement of controls in a crowded combat cockpit is such that one control is in the way of another, or that one of the controls hits his knee before it's moved through its full range, the pilot has incomplete

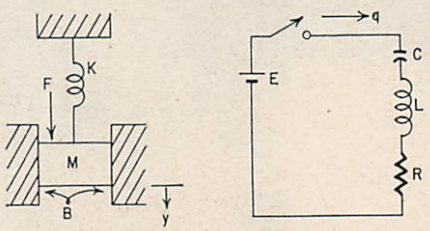


Fig. 1—The simple mechanical system on the left can be simulated with the electrical system on the right.

control. This limits the aircraft's capability and might spell disaster. Cockpit simulators which include analog computers are important tools for eliminating these possibilities.

Computers along the design road

Computers play an important role at every stage of aircraft development. Aircraft companies submit proposals to the military services to obtain contracts. A considerable amount of preliminary design goes into such a proposal. Even at this earliest stage of the operation, before a company knows it will manufacture the aircraft, computers enter the picture.

After the contract is awarded, additional design of a big-picture nature begins. At this stage, the specific design departments—aerodynamics, structures, propulsion, electronics—and the host of groups in these departments which participated in preparing the proposal have to pin down design details. The details worked out at this point are preliminary to problems like the control-valve and cockpit design. Again, the computer is an important tool.

And, there's a lot more to producing an aircraft than engineering. Plans are laid for production. Methods for the most effective use of manpower and machines are studied. Schedules are expanded and detailed so tooling and materials will be available when they're needed. Again, computers can help to cut that undertaking down to size. Even routine aspects of running an aircraft business, such as preparing payrolls and bookkeeping records, are simplified with computers. At Chance Vought Aircraft an IBM 704 digital computer aids the business offices as well as the engineering department.

But, again considering the details of aircraft development, the computer still has a host of jobs to do. After the best paper design is completed (and sometimes concurrently with paper design), aircraft and aircraft-system simulators are constructed and studied.

Aerodynamics, propulsion and surface-throttle controls are basic in the airframe design. But many other systems are essential in a modern piloted aircraft or in a missile. Electronics plays a vital role in most of these systems. The pilot needs a cockpit display of information pertaining to navigation and the status of the aircraft's numerous systems. Communications, guidance or navigation, and air-data systems are required. The armament and associated fire control fills the aircraft's basic weapon requirement. Air conditioning, pressurization, and cockpit design for pilot comfort under varying flight conditions are important. Autopilots to ease the strain on the pilot in high-performance aircraft or to control the entire mission flight of a missile are also essential. Weight distribution in the aircraft may be sufficiently critical to require complicated programmed control of fuel consumption. Some aircraft systems

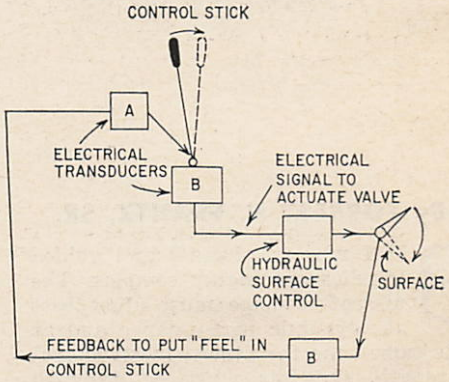


Fig. 2—Simplified diagram of one type of control system. Transducer A converts electrical signals to mechanical energy. Transducer B converts mechanical energy to electrical signal.

contain computers as part of the actual equipment.

Analog or general-purpose digital computers may be substituted in a simulation to arrive at specific airborne computer design. Special computer-circuit tools, such as the Heathkit Analog Computer and Computer Control Co.'s 3C digital-computer building blocks, are sometimes used to finalize computer design. They are also used to check electronic circuits that are not basically computers.

Problems are simplified by treating the various aircraft systems separately. But, eventually they must be integrated, and the first aircraft must be built. Then there's a period of checking on the ground. Finally, the aircraft is flight-tested. During the flight test, many measurements are made and a considerable amount of data recorded.

This data is reduced with computing equipment, and efforts are made to improve the aircraft and systems designs further.

Analog vs digital

There's no basis for arguments about whether analog or digital computers are best. For a specific problem one is usually better than the other. Quite often, though, it's a good idea to use both. General arguments of analog vs digital computers advanced in the earlier days of the computing art are no longer heard. Everyone associated with computers admits that the type used is determined by the problem.

If extremely accurate results are needed, a digital computer is best. It can handle discrete pulses which represent numbers, and its accuracy is limited only by the number of binary bits or decimal places designed into it. Large-scale digital computers such as the IBM 704 and the Remington Rand Uni-vac are mathematical machines and their operations are inherently arithmetic. Before an engineer's problem can be run on this type of computer, a rather extensive program must be prepared by a programmer from the engineer's statement of the problem.

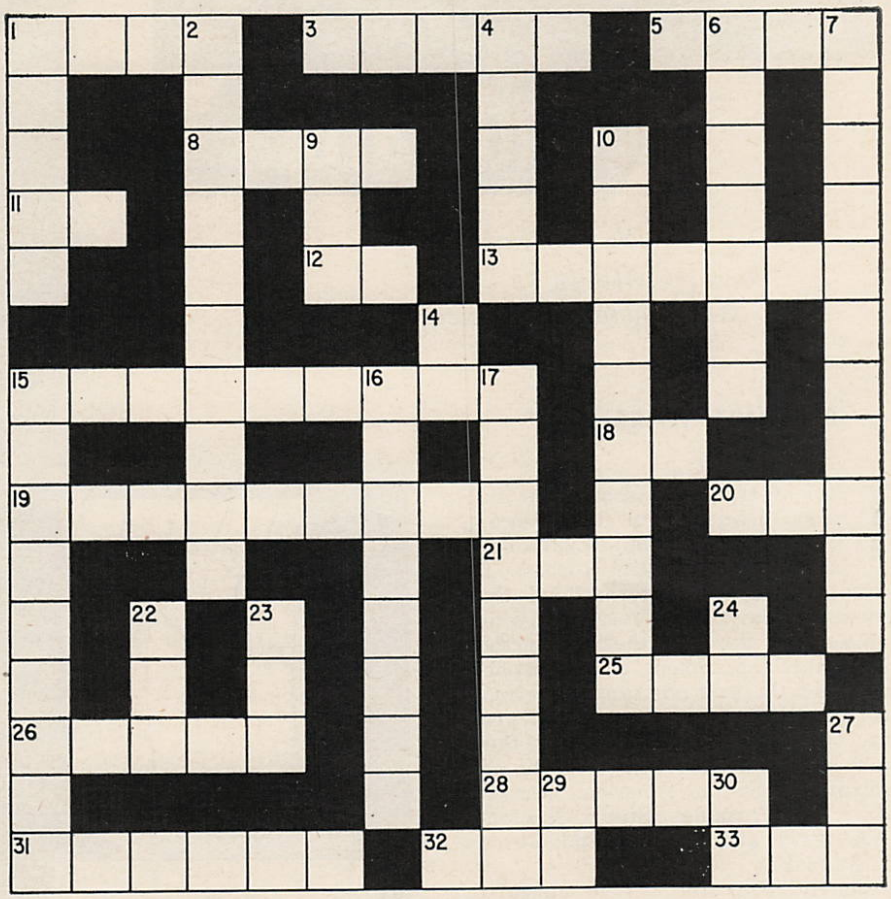
The engineer usually states his problem as a differential equation. This usually fits the analog computer directly and the analog computer is simpler to use in most simulations, too. In such a computer, an electronic amplifier with capacitor feedback forms an integrator. Integration with a digital machine is not as simple. Most engineers prefer analog computers for this reason.

At Chance Vought Aircraft, an extensive analog computing facility is kept continuously busy. But sometimes the accuracy of the analog computing equipment (0.1% to about 2% for most problems) is not good enough. Then, the engineer must seek a general-purpose digital computer to solve his problem. Or, he may resort to a digital differential analyzer (DDA). The digital differential analyzer operates with discrete numbers, but it integrates by incremental techniques. A problem is entered into a DDA in much the same way that it would be presented to an analog computer. This feature makes the DDA an important engineering tool which seems destined to grow in popularity in the aircraft industry.

Aircraft companies have sizable analog and digital computing facilities. They have proved valuable and are constantly expanded to increase their utility. END

ELECTRONIC CROSSWORD

By WM. R. SHIPPEE



HORIZONTAL

1. Equipment used to produce high-quality sound.
3. Instrument for checking waveforms.
5. Unit of power.
8. Every TV set uses electrostatic or magnetic ..... (abbr)
11. Remote control. (abbr)
12. Inductance-Capacitance. (abbr)
13. Tape recorders use these to remove sound from tape.
15. Used in most amplifiers to link one stage to the next.
18. Intermediate frequency. (abbr)
19. The imaginary part of impedance.
20. Transformer used at audio frequencies. (abbr)
21. Output stage. (abbr)
25. Used to convert ac to dc. (abbr)
26. Front-end of a TV set.
28. Transmission of code. (abbr)
31. Three-element vacuum tube.
32. Circuit used to generate alternating voltages. (abbr)
33. Input of most transformers.

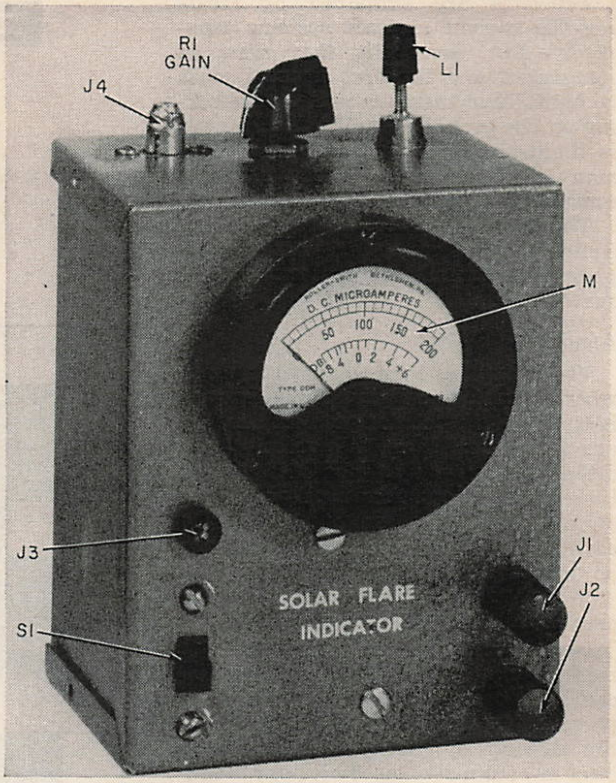
VERTICAL

1. A unit of inductance.
2. A coil has this.
4. Used as a signal pickup for test instruments.
6. A person who operates a noncommercial transmitter.
7. Every ham should have one of these.
9. Element of a vacuum tube. (abbr)
10. Semiconductor that is replacing vacuum tubes.
14. Barkhausen oscillation. (abbr)
15. Chemical solvent used in service work.
16. Used in the output stage of most transmitters.
17. Used to vary the amount of current flow in a circuit.
22. Type of transistor.
23. Part of a vacuum tube. (abbr)
24. Symbol for collector current.
27. Interference on TV band.
29. Electron-coupled. (abbr)
30. Ground potential. (abbr)

(Answer on page 135)

improved Solar Flare indicator

New circuit boosts sensitivity of 3-transistor SEA detector



By DAVID WARSHAW *

THE all-transistor solar-flare indicator described in the August, 1956, issue of RADIO-ELECTRONICS, has been contributing to basic research during the International Geophysical Year. This receiver, which detects solar flares by the SEA method (*S*udden *E*nhancement of *A*tmospherics), uses the first all-transistor circuit ever devised for this purpose. At present, the results obtained with these units are being carefully studied and coordinated by the American Association of Variable Star Observers (AAVSO†) and the National Bureau of Standards.

Shortly after the article appeared, letters expressing interest in the instrument arrived from all over the US and even from distant parts of the world. As a result, more than 20 of these instruments are aiding basic research and making valuable contributions to the fund of data being accumulated during the IGY. These instruments were built by readers who used the original circuit, supplemented by information supplied by the author.

Less than 2 months after the solar-flare indicators were in operation, the results shown in Fig. 1 arrived.

The SEA's on 27 kc (11,000 meters), which are caused by solar flares, are quite distinct in their shape on the recorder and are easily identified and separated from sudden increases caused by local interference (see Fig. 2).

Upper-atmospheric studies, through the use of rockets, have confirmed the belief that shortwave fadeouts are due to an extra layer of ionized air caused by X-rays emitted by the sun during solar flares. This extra layer extends down to about 12 miles below the normal lowest (D) layer. The D layer, 30 to 54 miles high, appears to remain undisturbed during the fadeout. It is this extra ionosphere, present during solar flares, that makes a better reflector for atmospheric pulses on 27 kc, thus causing a sudden enhancement of atmospherics. The atmospheric pulses originate in tropical thunderstorm centers, giving us a useful steady source of very-low-frequency radio energy.

Like other forms of basic research, recording SEA's is not without problems. One of the greatest is faced when a certain location is troubled with interference from sparking electrical appliances and TV receiver yoke leads radiating broadly near 31.5 kc—twice 15,750 cycles, the horizontal-sweep frequency. Sometimes, by moving

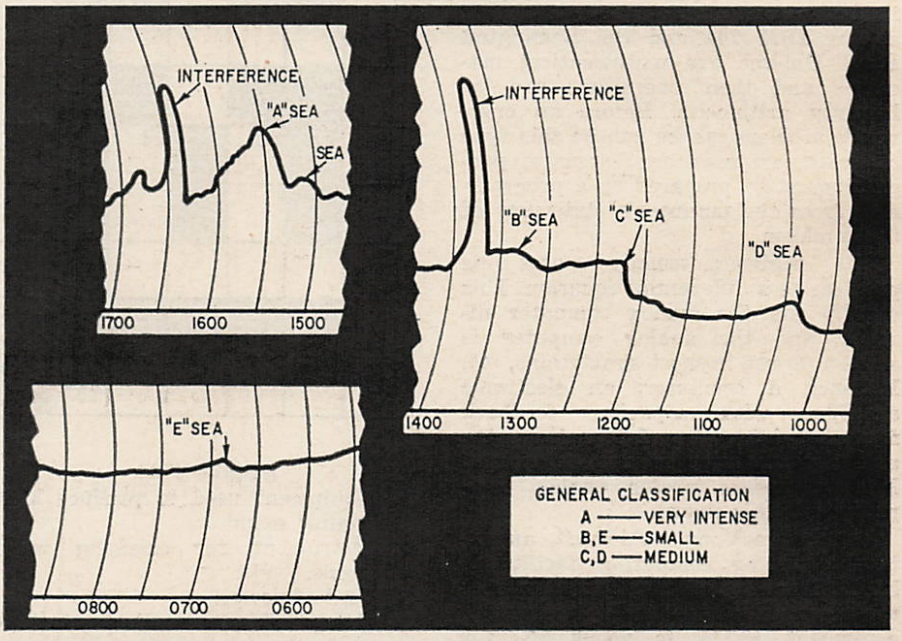


Fig. 1—First results using the 1956 circuit. Top left, Oct. 5, 1956 DST; top right, Oct. 6, 1956 DST; lower left, Nov. 1, 1956 EST.

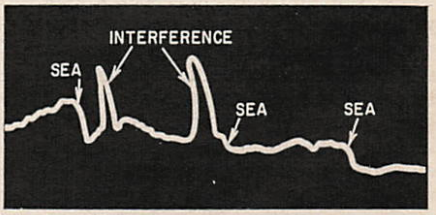


Fig. 2—SEA's and interference are easy to differentiate.

*Technical supervisor, American Cable & Radio Co. (ITT).

†The AAVSO is a scientific and educational organization which has been serving astronomy for more than 40 years. Headquarters are at 4 Brattle Street, Cambridge 38, Mass.

antenna and lead-in about 50 feet away from the source of interference, the trouble can be eliminated. Downtown Brooklyn is far from an ideal location, yet I have recorded hundreds of clear SEA's there during the past 2 years.

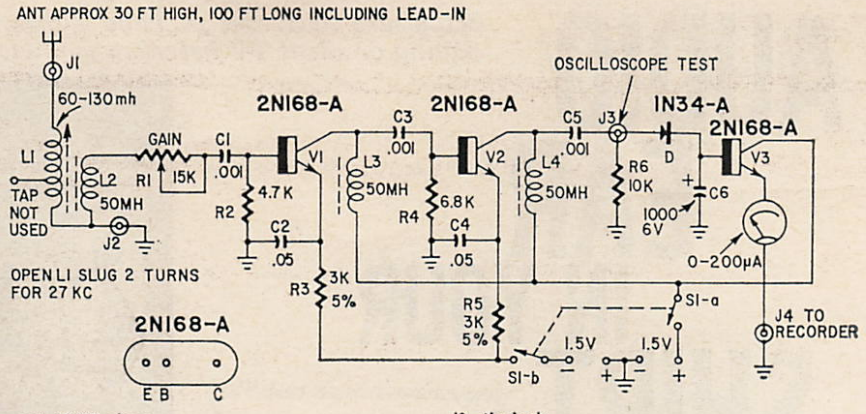
Circuit improvements

After 2 years of use, a number of improvements have been made in the transistor solar-flare indicator's circuit, and the recording system used with it. Any dc recording instrument with 100-μa full-scale sensitivity is suitable. In the original circuit, the second class-A stage was direct-coupled to the class-B stage, which used a separate battery. This lowered the unit's sensitivity as it put a slight reverse bias on the diode. Sensitivity was also dependent on the transistor's beta, which varies with temperature. Then too, the transistor's collector current was limited to 150 μa. In the new circuit (see Fig. 3), the last stage is ac-coupled, putting a slight forward bias on the detector diode. This increases the circuit's sensitivity and still requires only two batteries—one for emitter current bias and the other for collector supply voltage. Emitter current bias stabilizes the operating point. It is adjusted for about 500-μa collector current so the receiver now operates with a higher beta and is dependent only upon the transistor's alpha, which remains essentially constant with temperature variations.

This new circuit stabilizes the transistor's collector current against temperature variations. Collector current, without stabilization, increases with temperature and, in turn, boosts the power dissipated in the transistor, raising its temperature. This is evident from recorded traces showing objectionable oscillatory increases in the trace. Circuit stability depends on negative feedback (similar to cathode bias in electron-tube circuits). Emitter current is stabilized by the degeneration produced by the emitter resistor. At the amplified frequency, a shunt capacitor bypasses the rf around the emitter resistor. Current drain is less than 500 μa on each battery, which is about shelf life. L4 is a toroidal 50-mh inductor for even greater output and less stray magnetic field. L1 and L2 should be placed about ½ inch apart.

The transistor solar-flare indicator is small and inexpensive, putting it within reach of all who are interested in studying solar flares or wish to participate in basic research. This research will continue after the IGY has ended.

An unexplained phenomenon, first noticed by Harry L. Bondy, chairman of the Solar Division of the AAVSO, has turned up in SEA recordings—even though they were made in widely separated locations. There is a slight, but noticeable, dip in the tracings 35 minutes before sunrise. Then the trace rises again, forming a hump 20 minutes before sunrise. This is followed by the normal sunrise drop.



R1—pot, 15,000 ohms
R2—4,700 ohms
R3, 5—3,000 ohms, 5%
R4—6,800 ohms
R6—10,000 ohms
All resistors ½-watt 10% unless noted
C1, 3, 5—.001 μf, mica, 5%
C2, 4—.05 μf, disc ceramic
C6—1,000 μf, 6 volts, electrolytic
D—1N34-A
J1, 2—binding posts
J3—tip jack
J4—phono jack
L1—60-130 mh (Miller 6234 or equivalent)
L2, 3—50 mh (Miller 6310 or equivalent)
L4—50 mh toroid (Chicago Standard TM-50A or equivalent)
M—meter, 0-200 μa
S1—dpst, toggle or slide
V1, 2, 3—2N168-A
Case
Miscellaneous hardware

Fig. 3—Circuit of the improved instrument.

The sunrise drop is caused by atmospheric pulses reflected from the D layer, which does not exist at night, instead of the F layer. Since the D layer is lower, the signal is reflected with more hops from its source to the receiver and consequently there is more absorption. The cause of the slight dip and hump just before sunrise is unknown. Perhaps an explanation will come from some perceptive observer in the near future.

The AAVSO Solar Division's radio-astronomy program of recording SEA's is their contribution to the IGY. The National Bureau of Standards has supplied the AAVSO with four recorders to help in the project. The Solar Division started to make records of SEA's caused by solar flares immediately after several of its members built all-transistor receivers.

Mr. Bondy receives the recordings periodically and sends the tabulated results to the High-Altitude Observatory for the US–IGY Solar Panel, for publication in the National Bureau of Standards (NBS) monthly issues of Central Radio Propagation Laboratories (CRPL), *Series F, Part B, Solar Geophysical Data.*

Solar flares are classified by intensities. A class-3-plus flare causes the greatest disturbance to shortwave radio communications between 5 and 30 mc. In most cases, the duration, rather than the amplitude, of an SEA seems to be related to the associated solar flare's classification. A single location cannot produce the useful information that can be garnered by coordinating information from many locations. By doing this job, the AAVSO Solar Division performs an important and necessary service for the IGY. END

NEXT MONTH

FUZZBALL AND RED

are with us again in Bob Middleton's **Standing Waves and No Color.** Practical servicing and installation hints in the language of the younger TV servicing set. Don't miss it!

AMPLIFIER FOR YOUR TWEETER

Simple, easily put together 3-tuber handles the audio spectrum above 2,000 cycles, gives you a high-quality 2-channel system.

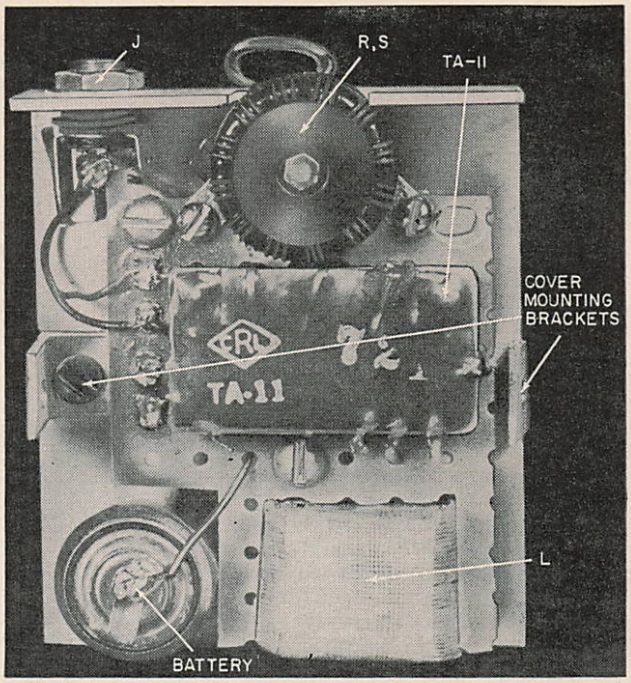
FOR 10 METERS.

There is practically "no limit to the distance possible" with this 10-meter receiver, built with 5 low-cost transistors by Don Hall, W5OBS. Bench-tested by RADIO-ELECTRONICS.

AUDIO EAR IN YOUR SHIRT POCKET

Miniature electronic package makes wireless paging or silent TV listening possible

By EDWIN BOHR and GORDON PETERS



Tiny size of parts makes this pocket-sized receiver practical.

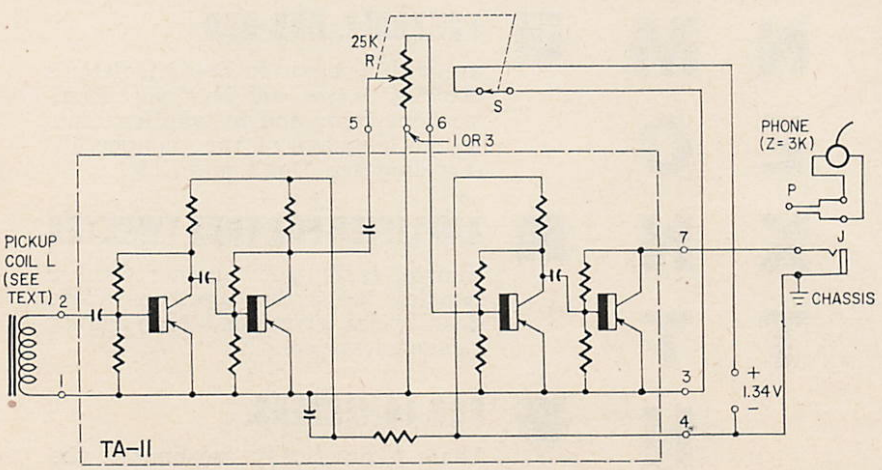
INDUCTIVE coupling makes a simple and effective wireless paging system for personnel walking about in TV studios, department stores, factories, offices and hospitals. Each person carries a small case containing a pickup coil, audio amplifier and mercury cell. The entire assembly is not much larger than a pocket package of matches.

An ordinary audio power amplifier feeds the audio signal to a wire loop surrounding the paging area. About 1 watt of audio for each 1,000 square feet of floor is sufficient. The resulting audio-frequency field is picked up by the induction coil, amplified and fed to a miniature earpiece.

You can rig one of these units so the kids can listen to the TV westerns or a hard-of-hearing member of the family can listen to a program as loud as he wishes without disturbing others. (And all this without entangling wires.) A TV set's output will saturate any but the largest living rooms with a strong inductive signal.

Many readers, experienced with electronics, are now asking, "And what about the terrific 60-cycle hum that it's going to pick up?" A natural question, considering the usual headaches caused by 60-cycle fields!

Nevertheless, 60-cycle hum problems are almost nonexistent, because 60-cycle magnetic lines of force are normally tightly concentrated around the offending transformers, motors and other equipment. So the signal-to-noise ratio is usually excellent. Reception is crystal clear and completely free of noise. Infrequently, a poor transistor will generate a quiet frying sound.



R—miniature pot, 25,000 ohms, with spst switch S
J—phone jack
P—phone plug
L—pickup coil (see text)
S—spst on R
TA-11, 4-stage amplifier (Centralab)
Chassis, aluminum, 1-15/16 x 3-1/16 inches
Cover, lucite, 3-9/16 x 2-1/4 inches
End, lucite, 13/16 x 1-15/16 inches
Battery, 1.34 volts, mercury (Mallory RM-1R or equivalent)
Miscellaneous hardware

Fig. 1—Circuit of the portable pickup unit.

Pickup unit

The pickup unit (see Fig. 1) is built around the Centralab TA-11 amplifier.

Wire Size and Resistance

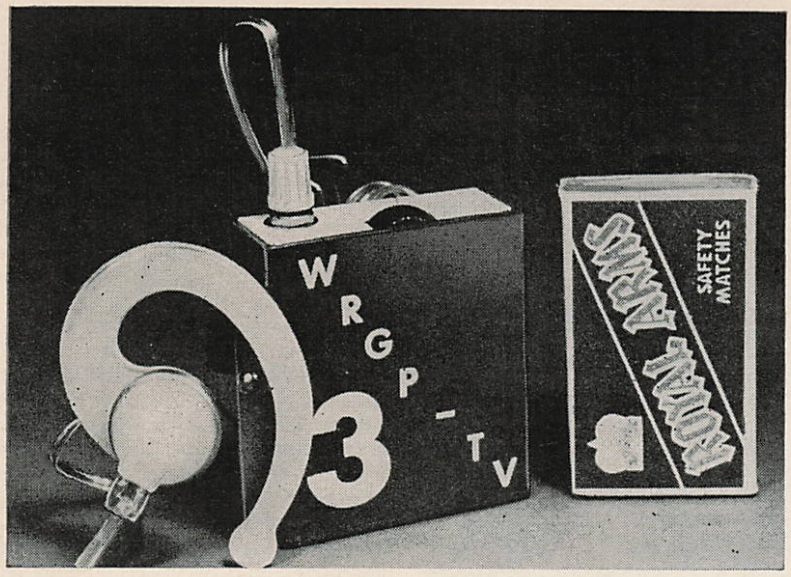
AWG	Resistance per 1,000 feet (ohms)
20	10
18	6.5
16	4.0
14	2.57
12	1.6
10	1.0
8	0.64

This four-stage transistor amplifier is completely wired, assembled and potted with epoxy resin in a ceramic "chassis." The constructor may, of course, wish to construct his own transistor amplifier, or use one already available. This can readily be done with some slight sacrifice in compactness.

A single mercury cell with an expected cell life of 250 hours powers the unit. Other components are a 1,000-ohm earphone (these usually have an impedance of about 3,000 ohms), a 25,000-ohm volume control and the induction pickup loop.

This pickup loop is home-made (see Fig. 2). We built ours around the center leg of a miniature transistor transformer core. Individual laminations are clipped with diagonal cutters.

Core size is not too critical, but the cross-sectional area should be at least



The finished unit isn't much larger than a box of matches.

1/16 square inch. The laminations should come from an interstage type transformer, since these use high-permeability core materials.

Signal pickup increases with larger core area and higher permeability. Core materials are annealed to increase their permeability. Therefore, keep cutting strain and mutilation to a minimum.

Wind about 2,000 turns of No. 32 enameled wire on the core. Either tape the core and wind the wire directly on it or make a small bobbin and wind the wire on that. Our coil was wound on a bobbin. The bobbin was then removed, the coil covered with tape and the core pushed into the center of the coil.

The core is mounted *vertically* to intercept the lines of force generated by a horizontal inductive loop surrounding the room or building.

As the photos show, we used a small piece of perforated phenolic board to facilitate mounting the amplifier and volume control. The control's metal mounting ears must be insulated from ground. So we simply bolted the control directly to the insulating board.

The board is fastened to the chassis with 4-36 screws and spacers. The holes in the chassis are tapped for the screws. These screws are cut to exact length so they fit flush with the chassis back.

The earphone jack grounds the negative side of the mercury cell. Since the jacket of the cell is positive, it too must be insulated from the chassis. Even though it does not show up in the photograph, I cemented a piece of cardboard under the battery to insulate it from the aluminum chassis. Use a rubber-to-metal type cement.

The case is made of aluminum and plastic (see Fig. 3). Its top and back form the aluminum chassis. A plastic cover for the chassis encloses the front, two sides and bottom areas.

Bending the aluminum is easy. Simply score the metal where the bend will be, clamp it along this line between two square-edge pieces of wood in a vise, and bend.

A similar procedure works with the plastic cover. Warm the plastic in an oven at very low heat, then quickly place it in a vise (as above) and bend it to shape. You can handle the warm plastic with cotton gloves. Now, cut out a bottom piece of plastic and cement it to the piece just bent. The best cement we have found is the type sold with Fiberglas kits in both automobile-accessory and boat stores. Follow the mixing directions exactly.

The average constructor will do a much better job cementing the plastic, rather than welding it with ethylenedichloride. Mix some Fiberglas with the cement and spread the mixture inside the case at the bent corners and junction with the bottom. This will reinforce the box tremendously.

When the cement and Fiberglas have hardened, you can sand them smooth, if necessary. Any pockmarks can be filled with a drop of additional cement.

Two angle brackets (shown in the photographs but not the drawing) should be placed conveniently to hold the plastic cover in place.

Now the case can be finished with a coat of paint. Red Krylon spray for the cover and white for the chassis make an attractive combination.

Where to use it

From the photographs, it is pretty obvious that this particular unit has been used for TV studio work. This is an application with a very real demand for "pedestrian communications."

The inductive system enables direct communication with people on the studio set who could not normally be entangled with trailing wires. In fact, the unit can be used by persons actually in view of the TV cameras, if the earpiece is artfully concealed.

In this instance, an inductive loop around the studio, fed by an 8-watt monitoring amplifier, delivers an excellent signal to any part of the two-story building and even across an adjacent six-lane boulevard.

However, too strong an inductive signal can be a real headache in a TV studio if it couples into tape recorders, microphones, low-level transformers and amplifiers. If this happens, try the following remedies: Reduce the audio drive to the inductive loop to a minimum, relocate the loop and provide better shielding for the low-level circuits.

Home installations are easy. Place the inductive transmitting loop under a rug, in the attic or basement tacked to either the floor or ceiling joists. In large buildings, the same methods can be used with more flexibility, since the loops can be placed around a picture molding or cornice or in false ceilings.

The loop should be matched approximately to the amplifier's output impedance. Essentially, the loop's impedance is the resistance of the wire. The table gives the resistance per thousand feet of common wire.

For living-room or home installa- (*Continued at bottom of next page*)

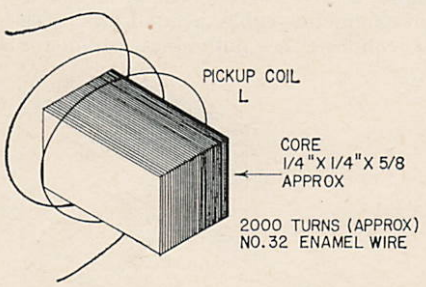
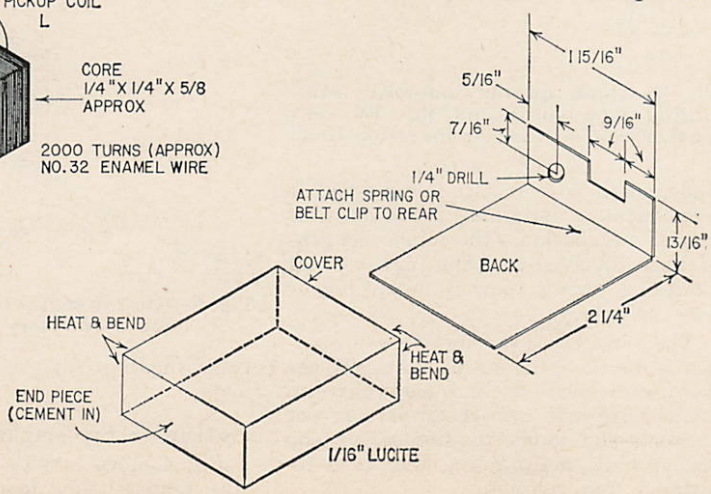


Fig. 2—Details of the pickup coil.

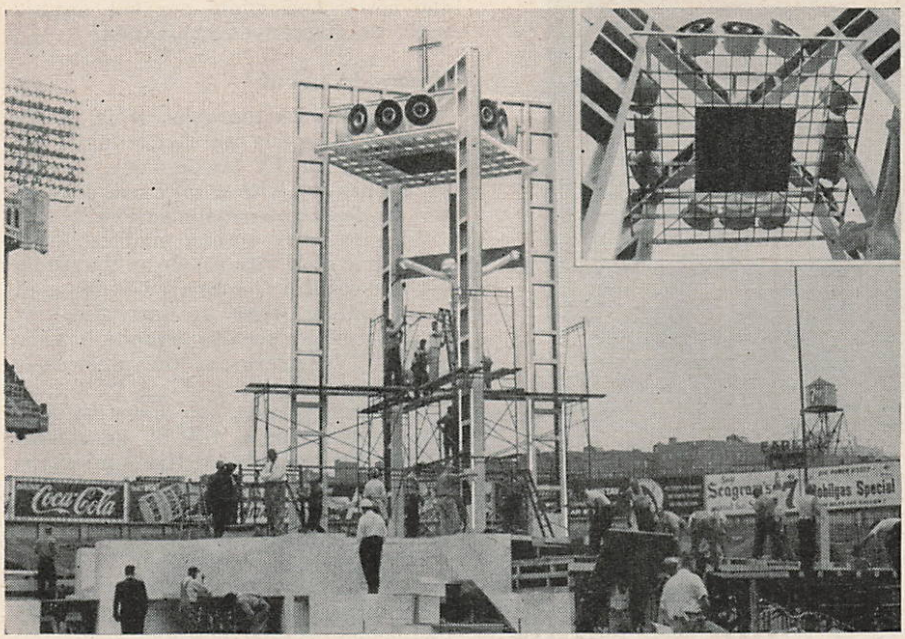
Fig. 3—Chassis and cover detail. Chassis is aluminum, cover is lucite or other plastic.



AUDIO—HIGH FIDELITY

HOW MUCH POWER for a STADIUM?

By HERMAN BURSTEIN



POWER amplifiers of 50 watts and more, and sometimes in excess of 100 watts, are being put into home use in ever greater numbers. Even though differences in speaker efficiency can account for as much as a 20-to-1 ratio between power requirements, there is still room to wonder whether all this power is truly needed for reproduction at, but not above, realistic levels. Cause for wonder increases when one learns that approximately 80 watts was recently found sufficient for a high-fidelity public-address installation in so vast a structure as Yankee Stadium in New York City, which seats 67,000 persons and encloses about 3 acres of field.

A typical living room has a floor area between 200 and 400 square feet and is 8 to 10 feet high. Yankee Stadium contains approximately 130,000 square feet, about 430 times as great an area. Moreover, it is an outdoor site, and the height of the stands is several times that of a living room. If 50 watts or more is needed for the home, it would seem that many times as much power would be required for the stadium. Yet 80 watts was all that was needed for high-quality reproduction at realistic levels on both music and speech.

This was demonstrated in the fall of 1957 when Francis Cardinal Spellman offered an outdoor mass at the stadium, using a specially engineered public-address system which was temporarily installed behind second base on the ballfield. As organ and vocal music figured prominently, the sound system had to meet high-fidelity standards. Instead of attempting to blast sound into every part of the place with tremendous power fed into a few speakers at one end of the stadium, 12 speakers were centrally located and arranged in a square for 360° coverage. With the aid of sound meters and walkie-talkies (for communication between technicians) the level of each speaker was adjusted to insure penetration of sound into every part of the stadium without noticeable echo effect or blasting.

The photo shows the installation, a 48-foot-high platform holding 12 University WLC speakers having a frequency rating of 50–15,000 cycles. They are of moderately high efficiency—somewhere in the 10–20% range—yet not appreciably more efficient than many speakers—particularly horn-loaded ones—found in the home. The system was installed by Edward P. Casey Sound Systems of the Bronx, N. Y.

AUDIO EAR in your shirt pocket *(continued)*

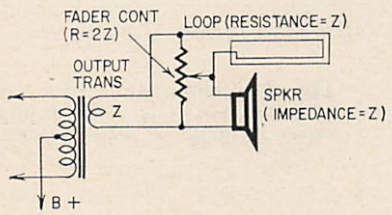


Fig. 4—Hook up the inductive transmitting loop so it and the TV set's speaker can be used at the same time.

tions, small wire is satisfactory and is economically optimum. However, for larger installations, the longer lengths of wire involved and the high cost of additional audio power make bigger wire necessary.

The inductive-loop signal is proportional to the number of turns in the loop multiplied by the loop current. Using wire with half the resistance per foot lets you double the number of loop turns, while maintaining the same resistance and current.

In smaller installations, rather than run a single conductor several times around a given area, string a single multiconductor cable around the area and connect the individual conductor ends together to form a continuous loop.

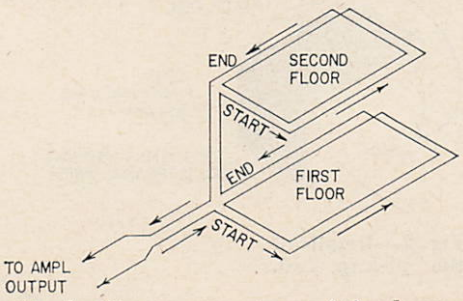


Fig. 5—How to set up transmitting loops for a two-story building.

Hookup to the amplifier

Fig. 4 shows how to connect an inductive transmitting loop, together with the existing speaker, to a TV set or amplifier.

For example, if the speaker impedance is 4 ohms, wind 4 ohms of wire around the pickup area and connect it as shown with an 8-ohm wirewound control. The control should be able to dissipate half the maximum audio power output.

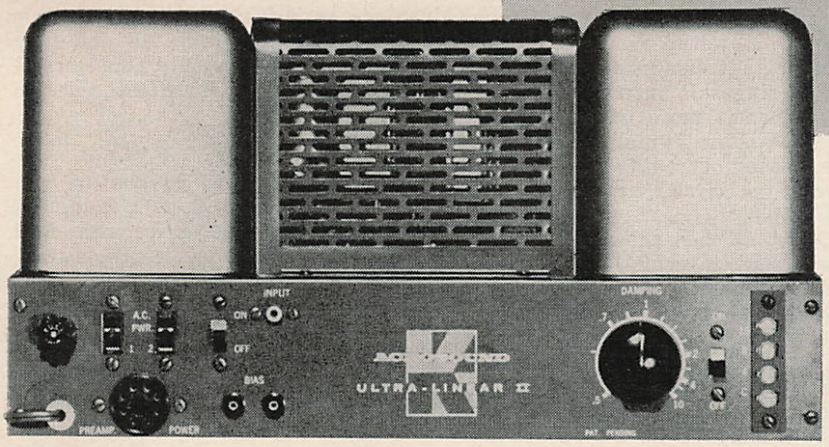
The control acts as a fader and feeds all the signal to either the loop or speaker, or divides it between them.

Fig. 5 shows a typical installation for a two-loop arrangement with the loops in series. The same idea is extended to multi-story buildings. This arrangement gives a more than adequately uniform inductive signal. The current must be flowing in the same direction in both coils at any instant. To connect the coils in parallel, be sure both start ends of the wire are connected together. END

Reference

Ray Zuck, "Audio Induction Paging System," *Electronics*, page 178, February, 1957.

STABILIZING FEEDBACK AMPLIFIERS



Part I—A good feedback amplifier must be stable. . . . Here are some ways of reaching this goal

By HERBERT I. KEROES *

AUDIO enthusiasts generally agree that the power amplifier largely determines the audio quality of an audio system. Of course, other components can also limit quality. But a good amplifier can make a mediocre speaker sound quite tolerable, while the best speaker will lose its virtues when connected to a deficient amplifier. Among "good" amplifiers there is a world of difference. Some sound smoother than others; some display muffled or muddy highs, and some break up in bass passages where an extra burst of reserve power is needed. This is true even of amplifiers with more or less identical specifications, including the power rating.

For several reasons, specifications alone do not disclose an amplifier's actual audio qualities. Amplifier specifications are not standardized and therefore do not permit an accurate comparison of quality. Often an amplifier will excel in some particular category, and this is featured in large type as a spellbinder. Consider harmonic distortion, for example. A figure of, say, 1% total harmonic distortion will be quoted, without stating whether the principal harmonic is third, fifth or seventh. It is well known that the seventh harmonic forms an unpleasant discord, while third and fifth harmonics produce only a coloration of the original sound.

The quantities that enter into measured specifications are all taken by steady-state sine- or square-wave excitation. But sound is not a steady-state phenomena. It is ever-changing in waveform, periodicity and intensity—it is transient in nature. The power amplifier must be able to handle the more difficult requirement of providing a burst of power, as in a kettle-drum passage, without noticeably disturbing the quality of a higher-pitched instrument, such as a flute, played in the same passage.

Finally, specifications are determined by laboratory measurements which do not realistically represent the conditions of actual use. One example is in the presentation of data taken using a rated resistive output load. Speakers are usually resistive over only a relatively narrow band of frequencies within their range, and at all other frequencies produce a reactive impedance several times nominal value. This causes an impedance mismatch which may increase distortion considerably. The amount of increase depends upon the output stage circuit, and it is well known that triode and Ultra-Linear[1] output stages produce less mismatch distortion than pentodes and tetrodes.[2]

So the specifications of an amplifier do not necessarily disclose its audio qualities and should be used only as a guide. An amplifier of good quality usually has excellent specifications. However, another amplifier having the same excellent specifications may produce inferior sound.

Feedback and stability

If an amplifier has reasonably good frequency response, low IM and harmonic distortion, and good square-wave response at 30 and 10,000 cycles, it is appropriate to look into how well these specifications are maintained under transient operating conditions. This is perhaps the crux of the problem.

We can then attribute any departure from steady-state performance, provoked by transient input signals, to instability in the amplifier circuit, and the general condition may be termed transient instability. Sometimes, the term syllabic distortion or instability has also been applied to the condition and is particularly appropriate since it gives an apt description of the here-and-gone quality of transients.

Both feedback and nonfeedback amplifiers can be unstable, each for different reasons, and the two types of instability can occur simultaneously in the same amplifier. One type of instability not caused by feedback is due to shifts of plate and grid potentials within the various amplifier stages. Amplifiers using class-AB output stages are particularly susceptible to this condition, since the large change in plate current causes a variation in power supply voltage due to the regulation of the supply. The plate voltages feeding the early stages are progressively decoupled, and in each voltage feed line there is a certain storage capacity in the electrolytic capacitors which tends to maintain the plate potentials for a limited time.

If the voltage suddenly drops in a plate feed line which, for example, is decoupled by 33,000 ohms and 20 μf, the voltage at the base of the plate resistor will drop by 63% of the total in 0.66 second. Cathode bias voltages are also bypassed by electrolytics, but generally have a different storage factor than the lines feeding the plates. Plate and grid voltages can therefore drift away from the optimum operating point, producing distortion. The condition is particularly troublesome in direct-coupled stages, since a small percentage change in plate voltage can produce a large-percentage change in grid bias of the following stage.

The remedy for instability of this type lies in using power supplies with good voltage regulation, decoupling networks with similar time constants, and voltage amplifier tubes operated at a mean optimum operating point. It is interesting to note that some of the partiality shown to high-power

* Acro Products Co., Philadelphia, Pa.

[1] US Pat. No. 2,710,312, assigned to Keroes Enterprises

[2] F. Langford-Smith and A. R. Chesterman, "Ultra-Linear Amplifiers," *Radiotronics*, May, June, July, 1955.

amplifiers may be due to sensitivity of the listener to the type of distortion described, since a high-power amplifier may just loaf along at listening levels that would set up large voltage variations in one of moderate power. Transient distortion is most likely to occur on overload, which presents the same problem in reverse—designing the decoupling networks for fast overload recovery.

Instability caused by feedback is a much more complex situation. Oscillation within the amplifier circuit is the general condition and may range from continuous oscillation, with the amplifier circuit completely disabled, to a less serious condition of excessive square-wave ringing. The oscillation may be ultrasonic or subsonic, and, therefore inaudible but representing a useless expenditure of power and detracting from the amount converted into useful sound. The fidelity of square-wave response may be affected in other ways, thus introducing factors which influence transient response.

Less distortion through feedback

All modern audio amplifiers use inverse feedback to minimize IM and harmonic distortion. Feedback has often been looked upon as the panacea for correcting all amplifier ills. When indiscriminately applied, it often fails to provide the expected results. For example, it will not correct distortion produced by an output transformer deficient in iron. However, it will linearize a nonlinear element such as tube transconductance, when the deviation from linearity is not too great or abrupt.

Inverse feedback is most intelligently applied when it is used to improve the characteristics of a good amplifier. In fact, the better the circuit is without feedback, the greater seems to be the reward. An additional benefit is obtained when inherent defects can be corrected within the circuit. One good example of this is the Ultra-Linear output stage. At equal output levels, the popular EL-34 in Ultra-Linear operation produces one-third as much distortion as when pentode-connected. At a fixed amount of feedback, say 15 db, total amplifier distortion is reduced by 15 db. However, to get the same maximum distortion figure, the amount of feedback for an Ultra-Linear amplifier can be 10 db less than required for a circuit with a pentode output stage.

There are many ways to apply negative feedback to a power amplifier. Early in feedback-amplifier evolution, negative feedback was fed from plate to grid of the output stage. Since the voltage gain of the power stage was small, the amount of feedback was limited. More grid drive had to be used and, consequently, more distortion was produced by the driver stage. These disadvantages soon outweighed the advantages, and only a small improvement was effected by this scheme.

It was soon recognized that feedback could be carried over both output and driver stages, thus relieving the driver of the burden of supplying excessive voltage, making possible an increased amount of feedback. This was later brought to the ultimate stage of development by taking feedback over the complete amplifier circuit encompassing all stages, including the output transformer. However, this is not without an important disadvantage. As the number of stages is increased, circuit stability becomes more of a problem, and in multistage amplifiers design must be carried out with extreme care to prevent the circuit from breaking into oscillation.

Practically all modern amplifiers follow the design in which feedback is taken in a single loop from the output winding of the output transformer to the input stage. The number of stages used is usually either two or three—the Williamson arrangement using four being an exception. The amount of feedback may be 12 or 14 db for the two-stage arrangements, and 20 to 26 db for three-stage amplifiers. The amount of feedback used is a compromise between maximum distortion, desired sensitivity and the circuit's basic stability. As the amount of feedback over an amplifier circuit is increased, at a certain value the circuit will break into continuous oscillation. The db difference between this value and the actual value of feedback used is often referred to as the amplifier's stability margin.

The instability point of an amplifier is not as abrupt as the condition of oscillation or no oscillation would lead one to believe, since other effects occur at feedback values between the nominal and absolute amounts. As feedback is increased, the amount of square-wave ringing also increases. Just before the circuit spills over, the amount of ringing may exceed the height of the square wave. Also, it is common practice to conduct amplifier tests on resistive loads equal to the nominal rated speaker impedance. Speakers do not represent a pure resistive load, and an amplifier that is completely stable on a resistive load may spill over on a speaker load. This is particularly likely with the capacitive load reflected by an electrostatic speaker or a two-wire speaker distribution system, and few feedback amplifiers remain really stable under such conditions. There are other aspects of performance which have a direct relationship to feedback stability which we will discuss presently but, at this point, it is sufficient to observe that *an amplifier of inferior stability will manifest itself by the way it sounds.*

Feedback design

Methods available to the feedback-amplifier designer allow a specific design to be carried out in a straightforward manner with accurate results. These are based on the fundamental feedback relationship which expresses the gain of a feedback amplifier as:

$$A = \frac{A_o}{1 + A_oB}$$

where A is the gain with feedback, A_o the gain without feedback, and B the fraction of output voltage returned to the amplifier's input. A_oB is the voltage gain looking into the amplifier's feedback loop and is called the loop gain. All quantities are vectors and have a phase angle. Therefore, it is possible for the denominator of the fraction $\frac{A_o}{1 + A_oB}$ to become zero (when A_oB is equal to -1).

When this occurs, the amplifier oscillates, since the gain with feedback becomes infinite. Hence, a feedback amplifier is stable if loop gain A_oB never becomes -1 or less at any real frequency. Note however, that this places no restriction on the loop gain becoming -1 at a frequency other than real. Such frequencies exist mathematically as an imaginary or a conjugate complex frequency—the real part being a real frequency, and the imaginary part a damped exponential wave. This describes a typical transient wave which may be made up of the sum of many such quantities. A single square wave may be expressed in this form and is certain to contain a quantity close to an imaginary frequency at which A_oB becomes -1.

If the imaginary component predominates, it is a damped exponential wave imposed on top of the square wave and, if small, the wave retains a smooth appearance. If large, the leading edge will show a spike. If the real quantity is dominant, an exponentially damped oscillation occurs, and the square wave exhibits ringing. At a particular mixture of real and imaginary frequencies, oscillation disappears and the top of the wave takes on an appearance of a small rise followed by a gradual exponential decay. This is called critical damping and represents a desirable compromise. However, the closer A_oB is to -1 at real frequencies, the greater the amount of ringing. Hence, an amplifier circuit may be analyzed for stability at real frequencies and an amount of feedback may be used below the maximum allowable at which oscillation occurs. The feedback range over which the amplifier rings falls within the area of the stability margin which was defined as the decibel difference between the actual amount of feedback used and that which produces continuous oscillation.

No standard value of stability margin that will assure critical damping of a square wave has thus far been determined. Some authorities feel that 6–12 db is sufficient. With this much feedback, the square wave may exhibit a small amount of ringing, say 5% or less. This analysis is usually conducted on a resistive load, and performance on a speaker load can be very much different. This leads us to point 2:

Perfection in performance depends upon achieving a maximum amount of

stability margin by design methods which rely on analysis at real frequencies.

Nyquist diagrams

The stability of a feedback amplifier may be analytically determined with a Nyquist diagram.[3] This is nothing more than a polar plot of loop gain A_oB taken over all frequencies from zero to infinity. A typical Nyquist diagram is shown in Fig. 1-a, and it is seen that it is the locus of the loop gain OA expressed as a vector. It was first demonstrated by Nyquist that, if the plot encloses the point located at −1, the amplifier will oscillate. Several types of Nyquist diagrams are interesting and of practical interest. They describe certain anomalies in the performance of feedback amplifiers which have not been fully explained.

Fig. 1 shows five possible Nyquist diagrams. In the interest of clarity, only half diagrams are shown, and are typical for the frequency range from the midband of the amplifier to either zero or infinite frequency. The diagram from mid-band to zero frequency is usually not similar in appearance to that taken to infinite frequency, and each half of the diagram must be considered separately. Fig. 1-a encloses −1 and the amplifier oscillates. Oscillation could be stopped by reducing the amount of feedback. This would, in effect, shrink the diagram and place −1 outside of it.

Fig. 1-b is of significant interest, since it describes a type of conditional stability called Nyquist stability. Note that −1 is not enclosed and the circuit is, in fact, stable. However, if the circuit loses gain or if the amount of feedback is reduced, the amplifier will break into continuous oscillation. Many feedback amplifiers exhibit this condition. For example, there is the amplifier that "tweeks" when it is turned on. In this case, circuit gain slowly increases as the tubes' heaters warm up. The diagram for a small amount of time goes through −1 and an audible "tweek" is heard. An amplifier with this condition is also certain to break up on peaks since, at maximum output, the output tubes clip, reducing the circuit's gain.

A similar situation occurs in a circuit that is Nyquist-stable if the output transformer is deficient in iron. Pockets of oscillation will be generated on the sides of a low-frequency sine wave when the amplifier is delivering nearly full output. In this instance, the iron in the output transformer saturates, which again reduces circuit gain, causing oscillation. Since the magnetic flux in the transformer core is 90° out of phase with the output voltage, the oscillation appears on the sides of the voltage wave. This gives rise to point 3:

The Nyquist diagram for a well designed feedback amplifier will not be of the conditionally stable type.

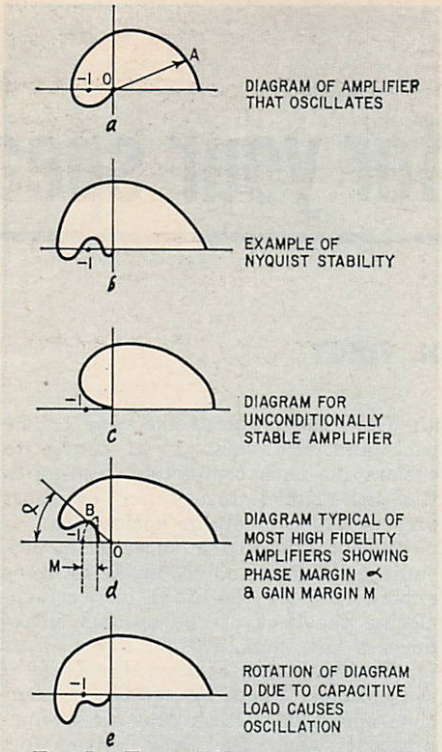


Fig. 1—Typical Nyquist diagrams for feedback amplifiers.

At this stage, it is wise to inquire what means are available to avoid Nyquist stability, what is the best shape of Nyquist diagram, and how may it be achieved. In Fig. 1-c oscillation is impossible, since no matter how large the diagram becomes, −1 will never be enclosed. This is a most desirable diagram, since it describes an amplifier of infinite stability margin. However, it may be achieved only for relatively simple circuits. The shape of a Nyquist diagram is determined by the total phase shift in the amplifier circuit caused by the sum of the individual phase shifts of interstage networks and output transformer.

Fig. 1-c is typical of a circuit containing two R-C-coupled stages. Since a modern amplifier must contain at least two stages, plus an output transformer, it is impossible to obtain a diagram of this type. Each additional stage adds phase shift, causing the Nyquist diagram to depart more and more from the optimum shape. Hence, we may make point 4. *A well designed feedback amplifier will contain a minimum number of phase shift networks, therefore a minimum number of stages.* This is carried into practice in the design of such amplifiers as the Mullard circuit which contains three high-gain low-phase-shift stages with direct coupling between two stages. The low-frequency Nyquist diagram has the appearance of Fig. 1-c, since only two phase shift networks which have an ultimate phase shift of 90° are present, the R-C network between driver and output stage, and the phase shift caused by the primary inductance of the output transformer.

Note that it may be possible to achieve a Nyquist diagram that approximates Fig. 1-c by staggering time constants of interstage networks. Hence, if one stage of a three-stage configuration can be given a greatly extended response, during which interval the gain of the other two stages is gradually attenuated, the amplifier behaves as a two-stage unit, and Fig. 1-c is approximated. In practice, a limited amount of improvement can be obtained in this manner. Design may call for staggering the time constants of interstage networks, extending the gain of one stage by video techniques or trading the gain of one stage for increased bandwidth. Also, at low frequencies, direct coupling or partial direct coupling may be used.

Fig. 1-d shows a Nyquist diagram for a stable amplifier. Note that the curve cuts away from −1 at a fairly constant distance. This distance is related to the circuit's stability margin. Hence, if it crosses the negative real axis at −0.5, the amplifier has a stability margin of 6 db. There is a definite design method to achieve this type of Nyquist diagram, desirable because it produces results which predict amplifier performance quite well.

The best known method is that of Bode.[3] This depends on the interrelationship between phase shift and the normal response curve of an amplifier without feedback. The response curve is shaped to fit the requirements imposed by the preferred Nyquist diagram. The response curve may be shaped by a variety of methods which include those mentioned—extending response, staggering interstages, etc.

One additional method is given. The practice of introducing shunt equalization networks between stages reduces maximum bandwidth but makes it possible to maintain more uniform feedback over the useful band and shape the Nyquist diagram to obtain maximum stability margin. The shunt networks introduce a plateau in the response curve outside the useful band, causing a phase reversal. These networks, also called step networks, are used in both the Williamson and Mullard circuits to obtain additional stability. We may then observe point 5:

It is desirable to obtain maximum feedback stability by making use of the methods of Bode to achieve an idealized Nyquist diagram of the type shown in Fig. 1-d.

All too often step networks are introduced on a hit-or-miss basis, and best results are not achieved. The introduction of these networks should be carried out to obtain a Nyquist diagram of ideal form.[4]

Now that we've covered the theory, next month we can go further and show just how the steps described in this article are actually used in a quality hi-fi power amplifier on the market today. TO BE CONTINUED

[3] H. W. Bode, *Network Analysis and Feedback Amplifier Design*, D. Van Nostrand Co. Norman H. Crowhurst and George Fletcher Cooper, *High Fidelity Circuit Design*, Gernsback Library, No. 56

[4] C. G. Mayo and J. W. Head, "The Impedance Concept," *Wireless Engineer* (London, England), April, May, 1956.

a BOX for your speaker

The best speaker enclosure is the one built around the particular speaker you intend to use. Follow the hints to good speaker design and end up with a better speaker system

By P. G. A. H. VOIGT

TODAY, many hi-fi enthusiasts are designing their own speaker cabinets. Can this be done successfully by rule-of-thumb methods at home?

This is one of those questions a straight "yes" or "no" does not answer. Just what do you really mean when you say "successfully"? From the idealist's point of view "successfully" might mean that the cabinet design should make the speaker, even if a poor quality, inexpensive unit, sound 100% perfect, with a level response curve and perfect transient performance. If that is your criterion I would say the answer is definitely "no". But if your criterion of success is that the sound should be considerably better than that from your neighbor's so-called hi fi, I think you will be reasonably successful, if you avoid major acoustic blunders.

If an ordinary moving-coil speaker is used without any baffle or cabinet, the lower frequencies are not radiated properly because the air particles simply flow around the edge of the cone from front to back and vice versa, and do not drive the air in the way necessary to set up a sound wave efficiently. This kind of short circuiting must be stopped or "baffled" in some way. The baffle, cabinet or enclosure (to use the present fashionable term) is used specifically to prevent such air flow around the edge of the cone. If a *small* flat baffle is used, flow still takes place around its edge. With a small baffle such flow is less than that around the edge of the cone when no baffle is present, but it takes a very large flat baffle to be really effective and prevent losses at the lowest frequencies. Such large baffles are cumbersome and difficult to disguise.

The so-called infinite baffle with the speaker mounted in a hole in the wall is the extreme case in which flow around the edge of the baffle is prevented completely (see Fig. 1). However, some people do not like making holes in the walls of their houses and besides, if someone slams the door, a delicate speaker may be injured!

The obvious way to prevent flow of air from the front of the cone to the back and vice versa is of course to enclose the back completely, leading to the box baffle, forerunner of most present-day cabinets or enclosures.

While the box baffle succeeds in preventing the flow and might therefore be expected to be the ideal answer, enclosing the back of the speaker introduces a new complication. *There is air in the box which encloses the back of the speaker.* Therefore, if the speaker cone moves backward, that air is compressed; when the cone moves forward, the air expands a little. The compression and expansion produce tiny changes of temperature which we need not worry about at present, but we do have to worry about the changes of *pressure*. The air in the box acts as a cushion which stiffens the whole system. This raises the cone's effective resonant frequency and diminishes its excursion at the lowest audio frequencies.

If the pressure changes caused by this cushion are negligible, relative to other pressures involved, we do not have to worry about their effect. That, however, usually requires a large-volume cabinet. The pressure change produced by a given cone excursion depends on the amount of the excursion, the projected area of the cone and the volume of the air cushion. The greater this volume, the smaller the pressure change due to a given cone excursion.

Cabinet size

When considering dimensions for a cabinet, remember that the area of the cone is involved in the relationship. If you have a 12-inch speaker, the 12 inches really relates to the "basket" holding the cone. The cone's base may have only a 10-inch diameter, so allowing for the fact that part of the surround is moving as well and ignoring minor corrections, the project area is about 75 to 80 square inches.

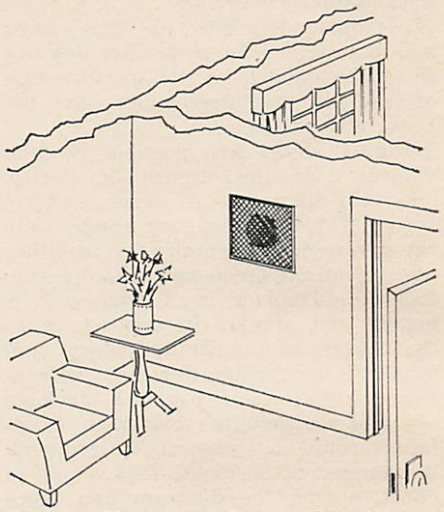


Fig. 1—Mounting the speaker in one wall of a room puts it in an infinite baffle.

On the other hand, if you have a 6-inch speaker, with a cone perhaps 5 inches in diameter, the projected area is much less, possibly only 20 square inches. Therefore, the little cone has to move four times as far as the big one to produce the same compression in the air cushion. That air-cushion pressure then reacts on the cone (of only one-quarter the area) so the actual force exerted on the smaller cone by the cushion compression is only about one quarter that which would have occurred with the 12-inch speaker. Since the small cone is probably stiffer to start with, and has to be displaced four times as far, the cushion pressure is relatively negligible compared with the other forces. Therefore, with a small cone, a smaller cabinet can be used. So the first thing to bear in mind when designing is simple. *Do not restrict the speaker cone's freedom of motion by making the box too small in comparison with the actual speaker with which the*

P. G. A. H. Voigt is known as the dean of speaker and speaker-enclosure design engineers. A pioneer in the field of electrical recording, he turned his attention to speakers in the early '30's and is credited with the invention of the "whizzer" cone (Hartley, RADIO-ELECTRONICS, March 1954). His "fabulous PM-2 driver" (Augspurger, RADIO-ELECTRONICS, May, 1955) and back-loaded horn, marketed by Lowther, established a standard when first introduced in Britain. Mr. Voigt, now in semi-retirement in Canada, has consented to write us a series of articles on speaker enclosures.

box is going to be used.

Building materials

That is not the only rule. In practice, things are rarely as simple as they seem at the beginning. For example, when you speak of a box, just what do you mean? Groceries are delivered in a cardboard box which might be big enough to put over the back of the speaker. But if you do that and play a record and put your hand on the side of the box you will find that at certain frequencies the side vibrates violently. Now, when the box side is vibrating, it acts as a supplementary speaker. Additionally, since the inner surface of that side is vibrating too, the air cushion is affected and reacts to some extent on the speaker itself.

Laboratory measurements show that under certain conditions the vibrating side of the box may be vibrating in just such a way that the sound which the box is supposed to be baffling is actually being helped to take short cuts at a particular frequency. So it is desirable to make the box of good healthy stuff, which, if it vibrates at all, will vibrate very little.

Rigid construction and internal bracing help to minimize vibration. Different materials also vary in their liveness. This concept of liveness in enclosure materials is most easily understood if we regard the enclosure as some kind of system that might vibrate if tapped. A church bell which is tapped vibrates on its specific resonant note for a second or more, but a piece of soft putty of the same shape will not ring at all. The deader the material, the less likely it is to ring and thus build up vibration at any frequency.

For practical reasons, plywood is generally used. Alternatives are devised from time to time for the building industry. By tapping these with your knuckles and listening you can soon learn how to judge their relative deadness or liveness. A dead-sounding material could be a very useful alternative to plywood. The tapping test serves another purpose too. If the note produced is high up the scale, it shows that the material is fairly rigid, while another material of the same dimensions which makes a low-toned note is probably less stiff. Since a good cabinet should be stiff and nonresonant, the higher-toned, deader material is preferable.

If these considerations covered the whole subject, cabinet design would be easy. It would just be a matter of learning how much space the lady of the house is prepared to allocate to the enclosure, and then making a box to those dimensions out of a fairly nonresonant material. Unfortunately things are not that simple. The trouble is that the air in the cabinet is not just a simple cushion behaving in a very dead manner and allowing itself to be compressed or extended by the cone's motion.

The velocity of sound in air is about 1,130 feet per second, so if the cone

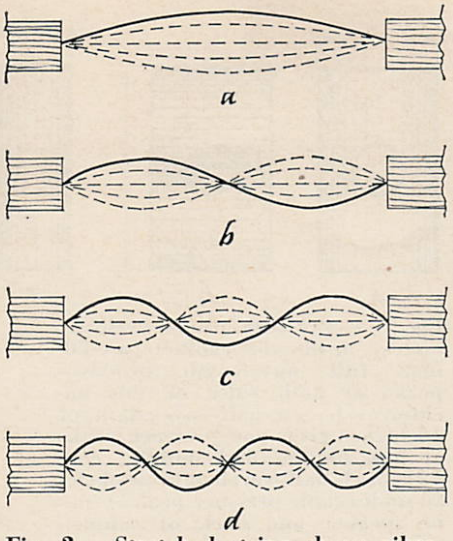


Fig. 2 — Stretched string shows vibration nodes.

moves, any air in the box which is 2 feet 3 inches away from the nearest part of the cone does not "know" anything about that movement until 1/500 second or so later. To make things clear, let us think in terms of a pressure wave; that is, assume the cone is moving inward during the 1/500 second in which the pressure wave is traveling to the part of the cabinet which is 2 feet 3 inches away. The pressure immediately behind the cone during that time is greater than it would have been if the compression had spread instantly to all parts of the cabinet and been distributed evenly.

Sound reflections

Suppose there is a boundary surface in the cabinet at this 2-foot 3-inch distance. The pressure wave, after meeting that surface, is reflected and so, another 1/500 second later, the reflected wave gets back to the back of the cone. A pressure wave from the back of the cone is thus partly returned, from the surface 2 feet 3 inches away, 1/250 second later. Any cabinet naturally has internal surfaces, and these, each at their various distances, contribute to the reflections inside. So inside the cabinet, a complicated pattern of primary reflections can be built up. These affect cone motion to some extent and in so far as they affect it, they are putting into the sound radiated from the front of the cone something which the amplifier is *not* supplying to the speaker. Unfortunately that is not all, for the reflections do not stop when they reach the back of the cone. The part of the reflected energy which is not absorbed at the speaker goes on bouncing about inside the box and, though some of the energy is absorbed at each reflection, quite a complicated condition is usually set up.

The cone, on any kind of sustained note, is moving alternately in and out. Since the rarefactions reflect in the same way as the compressions, the complications inside the box involve a mixture of compressions and rarefactions. If things can be so arranged that at any one moment the rarefactions meeting the back of the cone are equivalent to the compressions, the two cancel out and the cone is not affected. That would be a happy state indeed!

If we have an ordinary box, however —a rectangular one—at certain frequencies waves tend to build up between any pair of parallel surfaces. It is then very unlikely that the conditions for such cancellation would occur. More probably, air resonance inside the box will cause a wave buildup in one or more directions. Such a buildup, by acting on the back of the cone, affects its vibration much more than the primary reflection alone, and this affects the sound radiated from the cone face. Bad conditions occur if the sound buildup between one pair of surfaces is at the same frequency as the buildup between another pair of surfaces. The worst case occurs when buildup between all three pairs of parallel surfaces happens at the same frequency. Damping and other internal complications help diminish the trouble, but it is difficult to avoid all buildup between parallel surfaces.

If it is not possible to catch a trouble and strangle it at birth, the next best thing is to prevent it from becoming serious. Here, the trouble can be kept down by making sure, when designing, to arrange matters in such a way that the buildup frequency between one pair of surfaces does not coincide with that between other pairs.

The stretched string

To see how this can be done, let us take a moment to examine the standard textbook diagrams which show the vibration modes of a stretched string. Fig. 2 shows a string vibrating between fixed points in modes which include 1, 2, 3 and 4 half-wavelengths.

The wavelength is different in each case. Fig. 2-a with its two nodes (points where there is no motion) has the longest wavelength. In Fig. 2-b with its three nodes, the wavelength corresponds exactly to the distance between the fixed ends. In Fig. 2-d with its five nodes, two wavelengths fit into that distance. As the wavelengths become shorter and the number of nodes increases, each individual half-wavelength becomes less important.

In a stretched string the vibration corresponds to a *lateral* displacement. The stationary wave set up in an air column between two reflecting surfaces produces a *longitudinal* vibration of the air particles. At the nodes, however, there is no motion. When there are only two nodes, each situated at one of the two boundary surfaces, it is easy to see why there is no motion. When there are more, however, this is not as clear.

A stationary wave occurs when a wave traveling in one direction is reversed by reflection and the reflected wave interferes with the incident wave. Two equal waves in opposite directions are the exact equivalent. At the reflection points and also at intervals of

half a wavelength the motions of the two waves cancel exactly and produce the nodes. In the case of the air column, it is at these motion nodes that the maximum pressure builds up. Midway between them, where the particle motion builds up to a maximum, it is the pressures which cancel.

With the air column, just as with the stretched string, the lowest buildup frequency is such that the distance between the two parallel surfaces where the nodes form corresponds to a half-wavelength. If, in a rectangular cabinet, the height, width and depth are suitably related, it is possible to ensure that the several buildup frequencies do not coincide.

Nodes and cabinet dimensions

When working out suitable trial dimensions, remember if the speaker is located on the vertical center line, its position is midway between the two sides. It may also be midway between the top and bottom, but it is *not* midway between the front and back.

Before going into the details of the difference between the front-to-back wave and the others, it should already be obvious that making a speaker cabinet as wide as it is high, and mounting the speaker right in the center, would be a mistake, because buildup due to lateral reflections then occur at the same frequency as buildup due to the vertical reflections. Such combined buildup is far more objectionable than if buildup frequencies are staggered to occur at two distinct frequencies. The trouble from each is then less marked.

If we consider a cabinet 20 inches wide, the lowest-frequency standing wave which can be set up in the lateral direction has a half-wavelength of 20 inches. That half-wavelength standing wave has only two velocity nodes, and they occur at the two side surfaces. At those nodes, the pressure due to the standing wave builds up to maximum, but the air particle velocity is zero. Midway between them, on the cabinet's vertical center plane, is the region of minimum pressure and maximum air velocity due to that standing wave. Since it is *pressure* which affects the back of the diaphragm, that particular standing wave is not troublesome (see Fig. 3-a). The lateral standing wave likely to cause the most trouble is the one in which the 20 inches between the two sides corresponds to a full wavelength. *That* standing wave has a node on the cabinet's center plane, and that velocity node with its pressure peak is directly behind the cone. So, the trouble frequency due to the lateral standing wave is the one which corresponds to a half-wavelength of 10 inches.

If the cabinet is 32 inches high, we can use the same argument to show that it is the frequency which corresponds to a half-wavelength of 16 inches which excites the vertical standing wave with a node at the mid-level as well as at the top and bottom (see Fig. 3-b). The two frequencies corresponding to half-wavelengths of 10 and

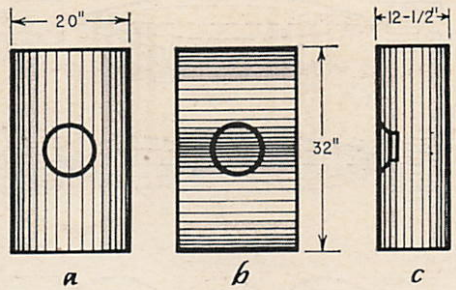


Fig. 3 — Pressure peaks (velocity nodes) inside the cabinet: a—20-inch full wavelength produces peaks at both sides of this enclosure; b — a half-wavelength of 16 inches gives you pressure peaks at top, bottom and middle; c — 12½-inch half-wavelength produces an undesirable pressure peak at rear of speaker and back of cabinet.

16 inches certainly do not coincide, so we would have two small and separate packets of trouble at different frequencies rather than one concentrated one.

With the back-to-front standing wave, we run into trouble when a pressure maximum (velocity node) is at the back of the diaphragm (see Fig. 3-c). The danger frequency is that at which one half-wavelength corresponds to the distance between back and front. If we make this 12½ inches, we will have staggered the three main trouble half-wavelengths to 10, 12½ and 16 inches. Since we are dealing with the air inside the cabinet, the dimensions discussed so far should, strictly speaking, be the inside dimensions, but the point to get home at this stage is the relationship between the several dimensions.

A cabinet whose external dimensions are 32 inches high, 20 inches wide and 12½ inches front to back looks well balanced and would have an internal volume of about 3 to 4 cubic feet. If the center of the speaker opening is above the mid-height, appearance is improved. Unfortunately, the best height for appearance of a simple box baffle such as we are discussing is undesirable acoustically.

It is possible to set up a vertical standing wave with three half-wavelengths in the vertical 32-inch dimension. In this mode of vibration there are four nodes spaced about 10½ inches apart. If the speaker is mounted 12 inches down from the top, this particular vertical standing wave could be excited, for the center of the speaker would then be close to the node, which occurs about 10½ inches down from the top. Therefore, it would be better to have the speaker mounted lower and only about 2 inches above the mid-height. Then it is reasonably clear of that particular node and that particular vertical standing wave, which is especially objectionable because its half-wavelength almost coincides with the 10-inch transverse one, would not be set up. If the front of the cabinet is covered with sound-transmitting material, the position of the speaker opening will not show.

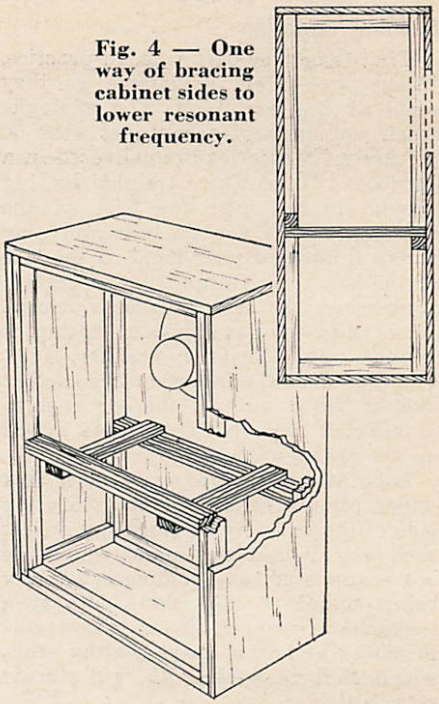


Fig. 4 — One way of bracing cabinet sides to lower resonant frequency.

Such a cabinet should be suitable for use with an 8- or 10-inch speaker and, if it is decorated to match the rest of the furniture in the room, it would probably be accepted by the lady in charge of domestic affairs. Speakers, 12- and 15-inch, unless very stiff, deserve a bigger volume. This also holds true for some 10-inch speakers with very free cones. A cabinet whose top, bottom and sides are only 12½ inches wide has considerable inherent rigidity if ¾-inch or thicker wood is used. However, unsupported front and back surfaces can be expected to vibrate violently at some frequency in the lower part of the scale. Such vibration can be diminished by cross-bracing and other reinforcement.

Bracing to lower cabinet resonance

A simple method is shown in Fig. 4. It consists of fastening a piece of 2 x 2-inch wood firmly to the inside of the front face just below the speaker opening. To the upper side of that piece attach two cross-struts whose length corresponds to the cabinet's internal front-to-back dimension. Above the back ends of those cross-struts attach another 2 x 2-inch reinforcement. The rear surface of this reinforcing strut should be flush with the rear of the sides. When the back panel is fixed, it is fixed around its edge, and *also* to the second reinforcement. These two reinforcing pieces together with the cross-struts stiffen up front and rear surfaces considerably. Of course, additional stiffening can be added.

Do not paint or varnish the inside of the cabinet as this prevents sound absorption by the pores of the wood. Ideally, internal sound should be effectively absorbed or damped out so unwanted stationary waves inside the cabinet cannot build up and the possibility of their affecting the external

sound becomes negligible. For this reason, a layer of sound-absorbing material on the inside walls is usually recommended. It is at about speaker height that such material on the rear and sides will be most effective.

The air cushion elasticity is in parallel with the cone support elasticity. If there is air damping inside, this also damps the air-cushion elasticity, and the cone resonance, modified by the air cushion, becomes less marked. Internal damping can thus have a direct effect on the external sound.

When fixing the back in place, do not glue it permanently into position. One day, access to the speaker will be necessary, so fix the back with screws. It is not necessary for the joint to be completely airtight, but it *is* necessary that, when tapped, the whole sounds solid and not buzzy or cracked. A buzz indicates that two parts are in contact but not firmly together. Test for this before fitting the back on. A poor joint which produces a buzz must be traced and put right. Being too economical with glue or screws can give plenty of trouble later. Test again after fitting the back. Soft packing between the back and the cabinet and the reinforcement should prevent a buzz caused by vibration between the back and the rest.

The final test is the ear test. Some people are concerned with organ pedal tones, some with the clarity or edginess of cymbals and triangles. But the real test of a speaker system is male speech. If that sounds boxy, boomy or unnatural in any way, something is wrong somewhere. It may be in the studio or the mike, but if the same kind of unnaturalness persists on all program sources the trouble is usually in the speaker or enclosure. END

STEREO DISC STANDARDS

* In stereo discs the two channels shall be right-angle modulations of a single groove.

* In the 45/45 system of stereo disc recording, the two axes of displacement modulation are inclined 45° to the disc surface.

* In 45/45 stereo discs, the right-hand information, as viewed by the listener, shall appear as modulation of the outer sidewall of the groove.

* In 45/45 stereo discs, equal in-phase signals in the two channels shall result in lateral modulation of the groove.

* Lateral modulation of the stereo disc shall produce equal in-phase acoustical signals at the speakers.

* The 45/45 system is recommended as a standard for stereo discs.

It is further recommended that:

* The desirable tip radius for reproducing stereo discs be 0.5 mil.

* Included angle of groove be 90°.

* The bottom radius of the groove of the finished record be 0.2 mil maximum.

These are the findings of the Engineering Committee of the RIAA as reported in their Bulletin E3. END

new DISCS and TAPES

STEREO and MONO

Reviewed by
Chester Santon
Station WQXR
New York City

TO do justice to today's stereo discs, the stereo pickup cartridge must be selected very carefully. A poor cartridge may result in an outlook as warped as the appearance of a few early stereo records. The performance of my latest magnetic stereo cartridge is superior to that of the two previous models used in reviewing discs. Consequently, stereo records evaluated in past columns sound better now than they did when first reviewed. Separation is improved. Bass response is firm and clean on records once considered deficient in that respect. Highs are sweeter. The absence of peaks in the latest cartridge solves previous surface-noise problems. One of the better stereo cartridges, tone arms and turntables playing today's best stereo discs can give stereo tape a run for its money on any system.

VERDI: *Il Trovatore*
Alberto Erede conducting Chorus of the Maggio Musicale Fiorentino and L'Orchestre de la Suisse Romande
London FFSS stereo records (3) OSA-1304

London's opera releases in stereo carry the new medium to heights undreamed of a year ago. Stereo really transports us to the opera house. The orchestra, spread out in an imaginary pit, stands apart from the singers, yet works with them to better effect. The stars, Renata Tebaldi and Mario del Monaco, shine in a new light. Now Manrico's voice in his Act I serenade preceding his encounter with the Count di Luna can be located several yards upstage. The famous *Anvil Chorus* is particularly effective on a wide-range system. In every way, this album is superior to the earlier monophonic version of the same performance.

GIORDANO: *Andrea Chénier*
Gianandrea Gavazzeni conducting Chorus and Orchestra of L'Accademia Di Santa Cecilia, Rome
London FFSS stereo records (3) OSA-1303

This companion operatic stereo release offers Tebaldi and Del Monaco in an equally clean-sounding recording. The story takes place at the time of the French Revolution. A stereo highlight is the courtroom scene in Act 3. For the first time on records, it is possible to separate the shouts of the crowd from the rest of the action as Chénier is sentenced to death by the tribunal. Exciting days lie ahead for opera fans. Angel's first release of opera on stereo tape will be reviewed next month.

Two for the Show
Tom and Jerry Vincent, Piano and Hammond Organ
Livingston stereo tape 1101 CX (7 inch; playing time, 31 min. $6.95)

Livingston is releasing tapes at 3.75 ips. Supplementing their regular catalog of 7.5-ips tapes, this new CX series offers two tracks on open reels. Switching to the slower speed of my two-track machine, I played this low-priced tape on the system normally used in reviewing stereo tapes. Also on hand was the 7.5 version of these same show tunes (Livingston 1101 F, $11.95). On a good unit, both reels exhibited identical steadiness of speed. The CX had tubby bass. The highs, of course, were restricted at the 3.75 speed when using the present-day two-track playback head. This resulted in severe loss of stereo effect. Signal-to-noise ratio, however, was surprisingly close to that of the 7.5 tape. Under these conditions, the new slow-speed tapes are adequate for background music.

Bob and Ray Throw a Stereo Spectacular
RCA Victor stereo record LSP-1773

Robert Bollard, formerly with Cook Laboratories, has joined RCA Victor as producer of stereo discs aimed at the 1959 audiophile. One of his first assignments rewards us with an amazing stereo record. Here are the most fabulous sound effects ever captured in a two-channel groove. The stereo rifle shots alone are worth the price of admission. Also heard are 10 samples of current RCA pop stereo releases. Top equipment will reveal the care and know-how lavished on this album. A more spectacular stereo record did not appear on the scene in all of 1958.

BEETHOVEN: *Symphony No. 3 (Eroica)*
Charles Munch conducting Boston Symphony Orchestra
RCA Victor stereo record LSC-2233

Problems still besetting some domestic stereo labels are to be found in RCA symphonic items released in October. This recording of the *Eroica Symphony* offers a ray of hope with fairly clean sound and passable highs and lows. But the Boston Pops *Marches in Hi-Fi* (LSC-2229) released at the same time sounds no better than the first RCA stereo record released last spring (*Hi-Fi Fiedler* LSC-2100). The stereo Dvorak *Fifth Symphony* with Fritz Reiner and the Chicago Symphony Orchestra is equally disappointing due to distortion. On the other hand, the Fiedler *Boston Tea Party* (LSC-2213) ranks with the industry's top items. Very puzzling.

HANDEL: *Organ Concertos Nos. 1–6*
E. Power Biggs, Organist
Sir Adrian Boult conducting London Philharmonic Orchestra
Columbia stereo record K2S-602

With this release of six Handel concertos for organ and orchestra, issued for the 1959 Handel Bicentennial, Columbia takes a good stride forward in its stereo process. Rarely have I heard such sweet, easy, undistorted projection of stereo sound. It closely rivals the best Columbia monophonic work being done today. The organ used was designed and played by Handel. Original scores and an orchestra of the size specified by Handel are employed. The English church currently housing the organ possesses unusually live and forthright acoustics. A wonderful stereo album.

Percussion in Hi-Fi
Ensemble conducted by David Carroll
Mercury stereo record SR-60003

This recording of a percussion orchestra advances the theoretical perfection date of the stereo disc. Distortion is held to the average found on the better mono records featuring per-

cussion. Exciting highs and lows now identify more easily the individual instrument heard within a group. The stereo-disc medium passes a severe test in this battle of wave-fronts.

GABRIELI: *Processional and Ceremonial Music*
Edmund Appia conducting Choirs and Orchestra of Gabrieli Festival
Vanguard stereo record BGS-5004

In this unusual release, the vocal pomp and splendor of 17th-century Italian music is heard in closeup. More than 300 years ago, Giovani Gabrieli anticipated our current interest in stereo when he composed these works for four organs and separated choirs. His experiments in the placement of double and triple choruses while organist at St. Mark's in Venice provide fascinating two-channel listening today. Monophonic recordings of this music failed to bring out Gabrieli's daring interweaving of sound. Unfortunately, no attempt was made to capture cathedral acoustics. Surface noise, a shade above normal, may cause trouble if your cartridge peaks in that region.

LISZT: *Four Hungarian Rhapsodies*
Anatol Fistoulari conducting Vienna Opera Orchestra
Vanguard stereo record SRV-108-SD

Vanguard submits records for review in these columns in both monophonic and stereo versions. The latest disc in their stereo demonstration series tops its mono counterpart. In each case, distortion is low. This gypsy music thrives in stereo. In the third Rhapsody, woodwind solos are centered while the harp and cimbalom—easily confused in monophonic days—are heard from the left and right, respectively.

Sounds of the Great Bands
Glen Gray and Casa Loma Orchestra
Capitol stereo record SW-1022

Stereo helps enormously in turning a trick seldom accomplished in the past. Famous arrangements long identified with 12 band leaders are revived in an amazing takeoff on the leading orchestras of the swing era. Middle-aged fans of Dorsey, Miller, Krupa, Thornhill, Herman, etc. will have difficulty believing their ears.

La Belle France
Carmen Dragon conducting Capitol Symphony Orchestra
Capitol stereo record SP-8427

Natural stereo breathes fresh life into Carmen Dragon's arrangements of favorites representing all forms of French musical life. This well-balanced record foreshadows the importance of good arrangers in the stereo age.

Die Engelkinder from Tyrol
The Engel Family
Vox stereo record ST-VX 25.650

The parents and seven children of the Engel Family are heard in an unusual program of Austrian folksongs and music for the Christmas season. Recorders and Renaissance string instruments supply a fresh, innocent background. Excellent stereo stems from the exceptional clarity of the sound.

PUCCINI: *Madame Butterfly*
Erich Leinsdorf conducting Rome Opera House Chorus and Orchestra
RCA Victor stereo records (3) LSC-6135

One of the three latest RCA opera sets is available on stereo discs. Coupled with the normal advantages of stereophony is a fresh, restudied concept of the opera as a whole. The young-sounding voices of Anna Moffo and Cesare Valetti are an integral part of this restoration. Frequency response more than meets the task of conveying the score's atmosphere of fragile beauty.

Favorite Songs of College Days
Marty Gold Chorus and Orchestra
Kapp stereo record K-1102-S

Exceptionally quiet surfaces set apart the first stereo releases from Kapp Records. Smoothly spread stereo and slight addition of echo rejuvenate these already hearty college songs.

VIVALDI: *Four Oboe Concertos*
Alberto Caroldi, Oboe
Piero Santi conducting Gli Accademici di Milano
Stereo VOX ST-PL 10.720

One of the early Vox stereo records (Vivaldi Bassoon Concertos) featured the same orchestra heard on this record. Comparing these two releases, issued some five months apart, it is easy to trace stereo disc progress achieved by Vox. The more recent disc displays the most noticeable improvement in the overall sound of the orchestra which in all probability was recorded in the same hall. Cleaner bass, robust upper middles and more transparent highs are to be found in the orchestral sound that supports oboist Alberto Caroldi.

LISZT: *Totentanz*
LISZT: *Malediction*
Alfred Brendel, Piano
Michael Gielen conducting Vienna Symphony Orchestra
Stereo VOX ST-PL 11.030

Now we're getting somewhere in recordings of the piano on stereo discs. Franz Liszt's chilling *Dance of Death* makes quite an entrance upon the stereo scene. With two channels sharing the burden, crashing piano chords can be properly handled on today's best equipment.

BEETHOVEN: *Piano Concerto No. 1*
BACH: *Piano Concerto No. 5*
Glenn Gould, Pianist
Vladimir Golschmann conducting Columbia Symphony Orchestra
Columbia stereo record MS-6017

The bubbling good spirits of the Beethoven concerto come to the surface more easily in stereo. In every way a top item.

Monophonic discs

Note: Records below are 12-inch LP and play back with RIAA curve unless otherwise indicated.

Drums on Fire
World Pacific WP-1247

Four drummers take turns challenging your monophonic equipment in this crisp, meticulously engineered disc. The highlight of the album is a set of Tabla variations played on the traditional two-piece drum of India by Chatur Lal. Different and dazzling.

Swingin' at the Cinema
Jonah Jones Quartet
Capitol T-1083

Perk up your tweeters with today's happiest trumpet on records as Jonah Jones bowls over a collection of movie tunes with devastatingly fresh sound.

En Avant—Marche
Band of La Garde Républicaine
Angel 35507

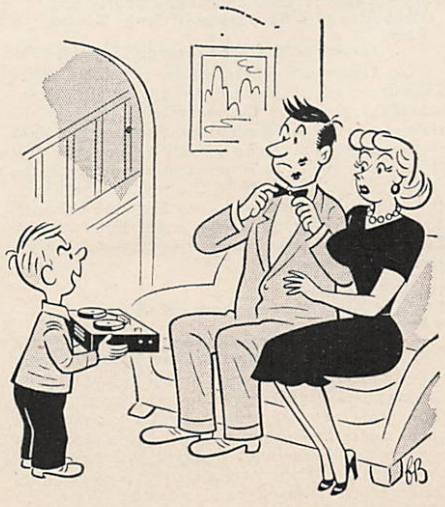
French military marches played in the crisp, distinctive style of France's leading band. Wide-range sound with a different tang.

BACH: *Art of the Fugue*
Arthur Winograd String Orchestra
M-G-M 2-E3

Bach's final work now heard in a new edition for string orchestra by Mr. Winograd. Four editions of the music preceded the present one. Because Bach did not indicate tempo, dynamics or instruments to be used, this two-record album will interest scholars and musical mathematicians. The close, intense pickup of strings is logical in this case.

Railroad—A Farewell to Steam
Hi-Fi Record R 901

Having heard the monophonic disc, I now want to sample the stereo version of this final trip of a Sante Fe steam locomotive. The journey, although a sad one for steam buffs, will continue to offer a wonderful excursion for your woofers for years to come. Specially designed Altec 21-C microphones fed the sound to an Ampex portable tape recorder with added preamp. Each potent transient during the trip from Los Angeles to Barstow stands ready to rock your system. especially on the heavy grades.



"I got it all on tape! What's it worth?"

Debussy by Firkusny
Rudolf Firkusny, Pianist
Capitol P-8451

Several years ago Firkusny's first solo piano recording for Capitol typified the new "natural look" in technical specifications. The ideal balance and completely free response of the earlier discs has been brought up to date. Better detail is available in the hushed passages as well as the full-voiced ones.

The Marvelous Miller Medleys
Glenn Miller and His Orchestra
RCA Victor LOP-1005

Miller fans will enjoy this latest pressing of eight medleys from Victor's vaults. The sound cannot meet today's standards yet quality is far superior to the original Bluebird 78's. Particularly interesting is the opportunity to A-B the styles of Glenn's civilian and Army Air Force bands. In fact, one selection, *Stompin' at the Savoy*, occurs in a medley by the civilian band and is later heard in a performance by the AAF band.

Only the Lonely
Frank Sinatra
Capitol W-1053

Sinatra's best mood album to date. Technically, this release is tops in its field. Scrupulously flat response permits full utilization of a wide-range system. Very highly recommended.

MOZART: *Symphony No. 40 in G Minor*
Eine Kleine Nachtmusik
William Steinberg conducting Pittsburgh Symphony Orchestra
Capitol PAO-8432

The two works most popular among Mozart's orchestral writings set forth with care and genuine modesty. The sound, being the latest, is very low in distortion.

ENESCO: *Roumanian Rhapsody No. 1 and 2*
TSCHAIKOVSKY: *Francesca da Rimini*
DVORAK: *Carnival Overture*
Eugene Ormandy conducting Philadelphia Orchestra
Columbia ML-5242

A particularly vivid example of sound quality sacrificed to crowd in an extra selection on one side of an LP. The eight other disc versions devote one side to Tchaikovsky's *Francesca*. Here Columbia jams in a Dvorak overture. The result: on good equipment, both selections on the side are deprived of today's normal bass response. There isn't room on the side to permit normal groove excursion. The Columbia LP of 1948, mentioned earlier, had bass to equal this at the same control setting. The usual Columbia tonal range may be found on the other side of the disc where it enhances splendid readings of the two *Roumanian Rhapsodies*.

Music of the African Arab
Mohammed El-Bakkar and Oriental Ensemble
Audio Fidelity AFLP-1858

More Oriental harum-scarum directed at those who like to judge an album by its cover. Sultry sound.

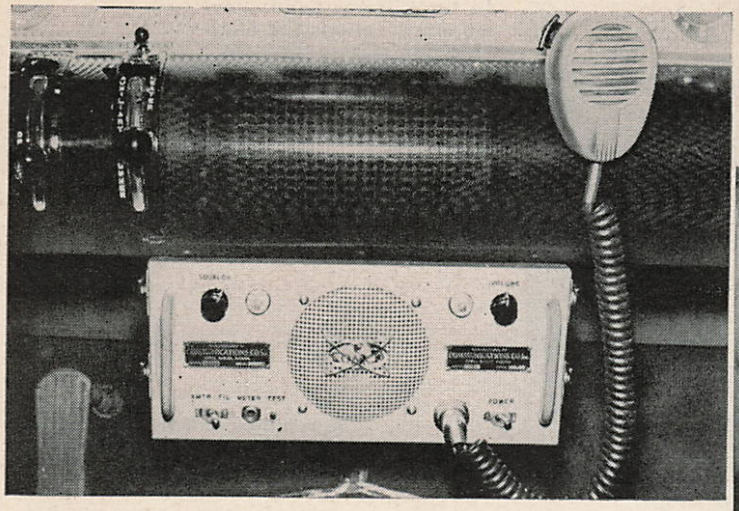
Jo Basile and His Accordeon di Roma
Audio Fidelity AFLP-1871

Light background music for the live-it-up set. Jo Basile's agile accordion skims through Italian favorites. One of the few instruments on this label that doesn't appear crowded by their ultra-close pickup techniques. No need of stereo here.

DEBUSSY: *La Mer*
RAVEL: *Mother Goose*
Ernest Ansermet conducting L'Orchestre de la Suisse Romande
Richmond B-19007

London FFRR is making available some of its early monophonic LP's at the new price of $1.98 under the Richmond label. This Ansermet performance is one of 18 well-known items in the first release. Although the sound is not a duplicate of the original pressings, it still surpasses reissues generally found on other labels in this price range. END

Name and address of any manufacturer of records mentioned in this column may be obtained by writing Records, RADIO-ELECTRONICS, *154 West 14 St., New York 11, N.Y.*



Mobile unit designed for under - the - dash mounting in a car or truck.

Photo Courtesy Communications Co. Inc.

Transmitter, receiver and power supply at base station are in rack cabinet in corner. Control unit is on desk.

Photo courtesy RCA

ABC's of MOBILE RADIO

Part I—You can get into mobile radio even if you know nothing of that branch of servicing, but a little knowledge of the special problems of that field is a big help

By LEO G. SANDS*

TODAY, any citizen of the United States over 18 years of age is eligible for a license for a private two-way mobile radiotelephone system, which can be used for business or for personal pleasure and convenience. No technical knowledge is needed.

Sales of mobile radio equipment are running at the rate of more than $89,000,000 per year. According to the latest FCC annual report, 1,200,000 transmitters have been licensed in all radio services combined. Each of the 390,000 radio-station authorizations covers one or more fixed or mobile transmitters. The 96,000 station licenses in the mobile radio services (land transportation, industrial and public safety) cover more than 875,000 transmitters, mostly mobile units. At the present rate of growth it won't be long before more than a million vehicles are equipped with two-way radio.

Mobile radio is used by almost every kind of commercial enterprise that uses vehicles. In addition, law-enforcement agencies in almost every community in the United States use two-way mobile radio. Factories, warehouses and wharfs use mobile radio to expedite material and merchandise handling. Power utilities, pipelines and railroads use mobile radio to communicate with vehicles traversing their rights-of-way. Motor trucks, railroad switch engines, taxicabs and tow trucks are regularly dispatched by radio.

While such enterprises have been permitted to use mobile radio for several years, radio and TV service shops, delivery services and just plain Mr. Citizen were not eligible until the Citizens radio service was established. The FCC opened the air lanes to the butcher, the baker, the candlestick maker and the housewife.

But the Citizens radio service took off slowly because suitable equipment was not available at first. When it became available, it was considerably more expensive than mobile radio equipment for the other radio services. It is only now that Citizens band mobile radio equipment, competitive in price with other mobile equipment, is starting to appear on the market. Notwithstanding the $200 to $300 price differential, more than 28,000 Citizens radio authorizations have already been granted, covering more than 100,000 mobile units. But the market has just been tapped. Its growth is expected to be phenomenal.

While hams can communicate with other hams anywhere, users of mobile radio systems must restrict communications to their own systems except in emergencies. For example, a taxicab dispatcher can communicate only with the cabs operated by his company. Special arrangements must be made with the FCC to permit joint use of a base station by two or more firms. In the Citizens band, however, a licensee may communicate with any other station with a Citizens radio license.

History

Mobile radio is not new. Before the turn of the century, Thomas A. Edison demonstrated a system which permitted telegraphic communication between a moving train and a way station, without requiring physical connections between the mobile and fixed stations. While Edison's system was really not radio, it was the great-grandfather of the mobile radio art.

About two decades later, mobile radio was used by the Lackawanna Railroad for communicating from a fixed point with moving trains. It was not until after World War I that one-way radio systems were adopted for transmitting messages from fixed points to moving vehicles. Police departments were among the first to use radio. Messages were transmitted by radio on frequencies just above the AM broadcast band. These were picked up by receivers in the cars. Since the vehicles were not equipped with transmitters, patrol-car crews had to reply by land telephone.

Radio amateurs contributed greatly to the development of mobile radio. Hams had already gained considerable experience operating on the 5- and 10-meter bands when mobile transmitters for use on 30–40 mc were introduced. In some early police radio systems, the base station transmitted to vehicles on

*Author of *Guide to Mobile Radio*, Gernsback Library No. 77.

In the Citizens band, service organizations are eligible for station licenses.
Photo by Cyril Glunk

A remote-control point for a base station equipped with a dial type selective calling.
Photo by Lars Speyer

the hf band and mobile units used AM transmitters operating in the 30–40-mc vhf band. Later, mobile vhf transmitters were developed. Some early sets used superregenerative receivers, but these were soon outmoded by crystal-controlled superheterodyne units.

Early mobile radio systems were AM. Shortly before World War II, the public was exposed to FM and, when the mobile radio business really got going at the close of the war, most manufacturers had started turning out FM mobile radio equipment. Some held out for AM but were forced to switch to FM because of popular demand, but not because of technical considerations.

The AM-vs-FM controversy is still with us. Most equipment now in use is FM. However, AM has been reintroduced in some current models. For example, the Kaar IMP (Industrial Mobile Phone), a low-power industrial radiotelephone for the 25–50-, 118–132- and 152–174-mc bands, is an AM unit. Amplitude modulation was chosen because it permitted the design of a more compact product and is compatible with aviation radio systems, which use AM exclusively. Another manufacturer, Bennett Laboratories, is introducing an AM 450–470-mc mobile radio.

While it would seem that there is plenty of air space for all who want to use mobile radio, extreme congestion is already a problem in highly populated areas. To make more channels available, industry is exploring the radio spectrum above 890 mc as well as AM, single-sideband AM and narrow-band FM, all of which require less band space than existing FM systems and permit narrowing the space made available to individual licensees.

Until recently, nearly all FM mobile radio systems used a 5-to-1 deviation ratio, the frequency being shifted as much as 15 kc above and below the center frequency by a modulating signal with a top frequency of 3,000 cycles. To conserve spectrum space, some mobile radio systems use narrow-band FM where deviation is limited to 8 kc above and below the center frequency. Philco, for example, produced 30–40-mc equipment in 1949 in both narrow-band and standard deviation types.

Now, the FCC is splitting mobile radio channels so that many additional frequencies will be available. In the 152–162-mc band, where individual channels were spaced 60 kc apart, 30-kc separation is being adopted. Channel splitting, which makes more channels available, requires narrow-band transmission and equipment with greater transmitter frequency stability and receiver selectivity.

Communication at higher frequencies has been tried experimentally and in the not-too-distant future commercial equipment will be available for frequencies above 890 mc. More than 10 years ago, the Rock Island Lines and Sperry Gyroscope Co. experimented with train radio equipment for 2600 mc. These tests conducted under the supervision of Ernest A. Dahl, now a consulting engineer and then electronics engineer for the Rock Island, showed that useful results could be obtained. However, at that time, suitable equipment for this purpose could not be produced at reasonable cost. Nevertheless, these early tests proved that microwave mobile radio is feasible.

Kinds of systems

A mobile radio system generally consists of a base station and one or more mobile units. It can have two or more mobile units and no base station. Or it may have two or more base stations and a number of mobile units.

A base station may be a compact, single-package transmitter–receiver assembly set on a desk and operated locally. Or it may be an elaborate rack-and-panel assembly installed in a shelter on a mountaintop and controlled from a point many miles away.

When there is more than one base station, they may be controlled at their respective locations or from a central point, selectively or simultaneously.

Right-of-way radio systems (see Fig. 1) may use wire lines or microwave circuits for remote control of two or more base stations. A pipeline or railroad may install unattended base stations every few miles along its right-of-way for communications with mobile units anywhere along its route. The base-station operator at a central point hears signals from mobile units that are picked up by any of the base sta-

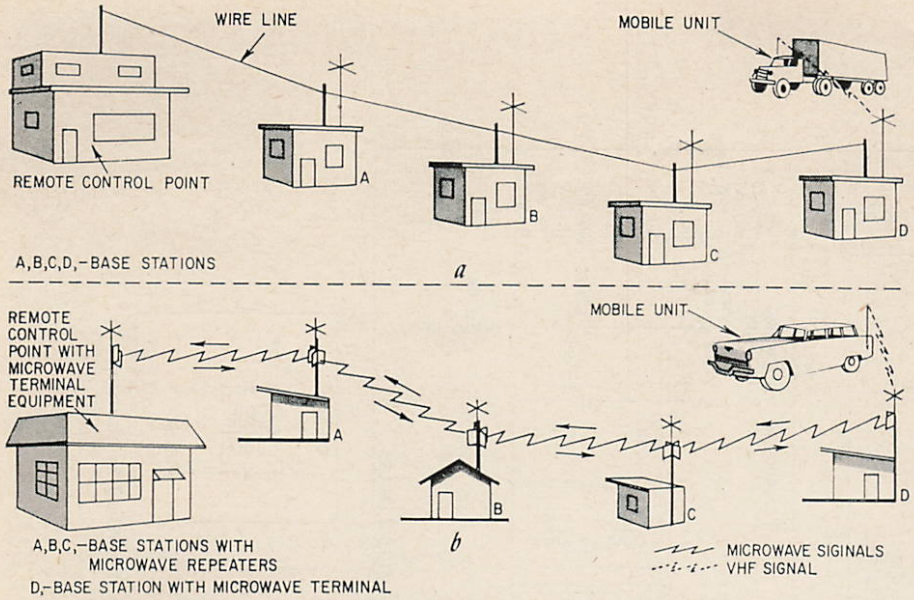


Fig. 1—Right-of-way mobile radio systems: a—all base stations may be connected to the remote-control point by wire; b—a microwave relay system may be the connecting medium.

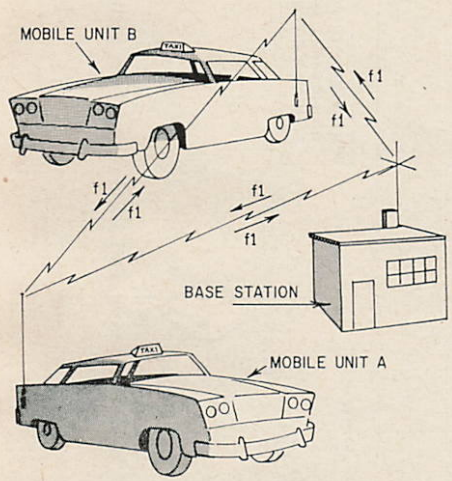


Fig. 2—Single-channel simplex operation. Base and mobile stations use the same frequency.

tions. With a telephone dial or pushbuttons he can turn on any of the base-station transmitters along the right-of-way when required. In some systems he can mute all receivers except one when communicating with a specific station. Other systems may use more complex controls.

A mobile unit generally defines a radio station installed on a vehicle. A typical mobile unit includes a transmitter and receiver housed in a single enclosure mounted under the dash or in the trunk of the vehicle. A mobile unit may also be a hand- or pack-carried portable unit.

Most mobile systems are two-way. However, there are one-way systems such as those used for paging. Subscribers to a radio paging service listen with a pocket-size radio receiver or a mobile receiver in a vehicle, replying by land telephone. In some railroad yards, one-way portable transmitters are used for talking to yardmasters and other supervisors, who reply over a loudspeaker paging system.

Generally, mobile units and base stations operated under a single licensee transmit and receive on the same frequency. Thus, all stations, both mobile and base, overhear all conversations from other associated stations within range. Operation is *push-to-talk*—the transmitter is normally turned off and is energized only when working. When transmitting, the receiver is disabled. A push-to-talk switch or pushbutton, generally located on the handle of the microphone or handset, disables the receiver and energizes the transmitter. To listen, the operator releases the push-to-talk button, reactivating the receiver and shutting off the transmitter. Two-way communication is maintained, but in only one direction at a time. This is called a *simplex* system (see Fig. 2).

Some mobile radio systems are two channels (see Fig. 3). In taxicab radio systems, for example, the base station transmits on one frequency and the mobile units on another. The base station receiver is tuned to the mobile units' transmit frequency and the mobile receivers are tuned to the base station's transmit frequency. The base-station operator hears only the mobile units and the mobile units can intercept signals from the base station only. Communication between mobile units is not intended.

Common-carrier mobile telephone systems also operate on a two-channel basis. The base station transmits on one frequency and the mobile phones on another. The mobile units use the push-to-talk technique, activating the transmitter only when talking and disabling it when listening. However, the base station transmits and receives simultaneously. This is a form of *duplex* system.

All radio stations, except those operated by hams and those licensed in the Citizens band, are authorized to transmit only on frequencies specified on the license. Sometimes a radio station is licensed to operate on two or more frequencies. In the 460–470-mc Citizens band, specific frequencies are not assigned and licensees may operate on

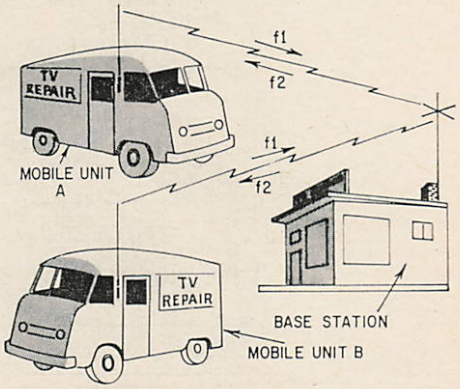
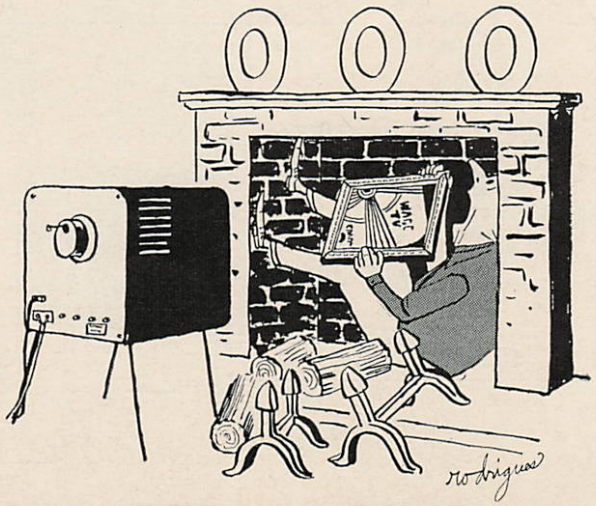


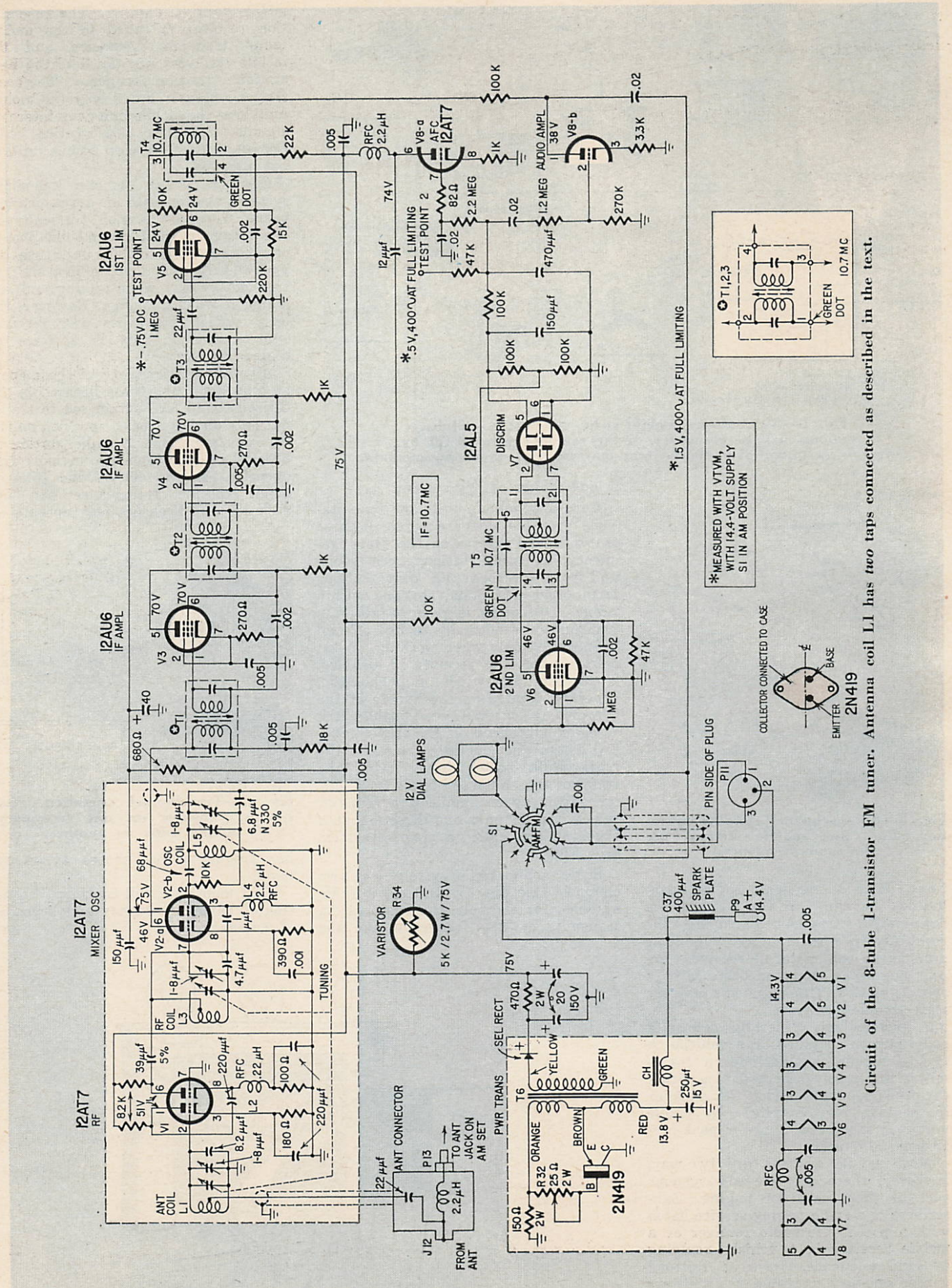
Fig. 3—Two-channel operation. Base station transmits on one frequency, mobile units on another.

any frequency they choose within the band.

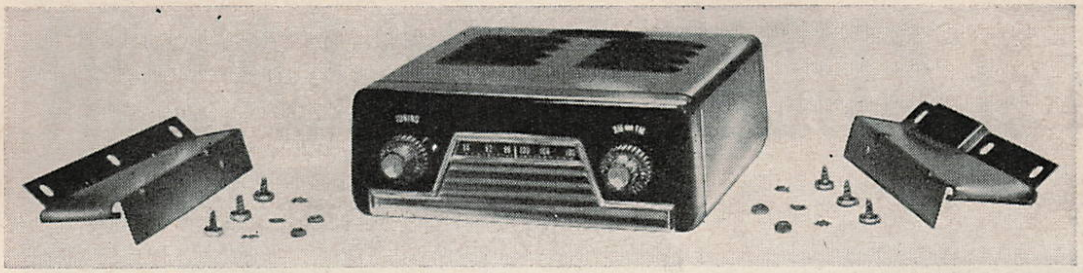
Next month we will continue, discussion of range, frequency and licensing of mobile radio. END



"Can you see it all right, Al?"

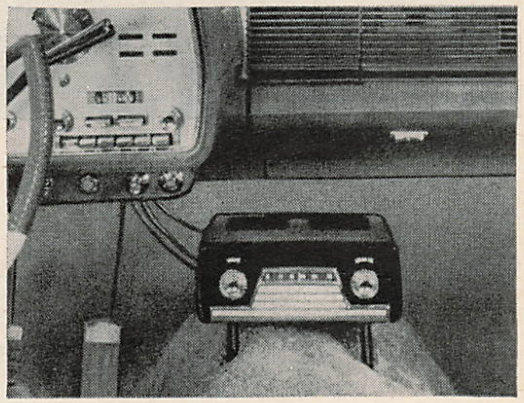


Circuit of the 8-tube 1-transistor FM tuner. Antenna coil L1 has *two* taps connected as described in the text.



The FM88BH tuner shown with the required mount-brackets.

The installed tuner mounts on the transmission tunnel and fits right in with the auto decor.



FM TUNER for your CAR

FM tuners for automobiles now come as factory installed equipment

By HENRY O. MAXWELL

SINCE the early 1930's American motorists have listened to their favorite sportscasts, news, music and drama on AM auto radios while driving over the nation's streets, highways and byways. All too often, reception is marred by atmospheric static, interference from leaky power lines and neon signs, radiation from electric and electronic industrial apparatus and other forms of interference common to AM radio. Now, some lucky drivers can enjoy noise-free FM reception comparable to that available from their hi-fi tuners at home.

Until recently, only a few custom FM tuners and German FM–AM receivers for cars have been on the market. However, the set described here is available as a factory-installed unit.

The Bendix model FM88BH (Lincoln model FFC-15491-B) FM tuner is available for owners of 1958 Lincolns equipped with the 1958 Bendix-Lincoln Travel-Tuner AM radio (Bendix model R85BH, Lincoln part No. FFC-18805-C, -D). A similar model is available for 1959 cars.

The FM tuner (diagram p. 56) is an eight-tube superhet type powered by the car's 12–14-volt storage battery and a transistor B-supply. Its power input is 2 amps at 14.4 volts dc. Sensitivity is 10 μv for 30-db quieting and audio output is 1.5 volts rms for full limiting. The tuner receives its primary voltage through plug P9 and a matching jack on the AM radio and feeds its audio output through plug P11 into the radio's first af amplifier.

Switch S1 selects the mode of operation. In the AM position, the audio output of the radio's AM detector enters the tuner on pin 1 of P11, passes through S1 and on to the radio's first af amplifier through pin 3 of P11. The output of the tuner's af amplifier (V8-b) is grounded to prevent feedthrough. In the FM position of S1, the AM output is grounded, V8-b's output is fed to the radio's af amplifier and the tuner's dial lights are turned on.

The circuit

Rf amplifier V1 uses a 12AT7 in a low-noise cascode circuit. The antenna coil (L1) has two taps. One is wired through a length of shielded cable to antenna connector J12–P13. This connector is inserted in series between the antenna lead-in and the antenna terminal on the AM radio. The tap near the grounded end of L1 provides the proper match between the antenna and the grid circuit. The input grid of V1 is connected to the upper tap on L1. This minimizes circuit loading and insures good front-end selectivity and sensitivity.

The plate of the output (grounded-grid) section of the cascode rf amplifier is coupled to the grid of mixer V2-a. This grid is tapped down on rf coil L3 to increase further the selectivity of the front end. Oscillator V2-b is connected in a modified Colpitts circuit with feedback voltage developed across an rf choke (L4) in the cathode circuit (see *Radiatron Designer's Handbook*, 4th Edition, page 952).

The two-stage if amplifier uses sharp-cutoff 12AU6's. The if amplifier is followed by 12AU6's connected as cascade limiters operating with low plate and screen voltages and grid-leak bias. Bias is adjusted so the limiters saturate at low levels to provide good AM rejection.

The FM detector is a 12AL5 in a Foster-Seeley discriminator circuit. Its af output is applied to the grid of audio amplifier V8-b through a de-emphasis network. The dc output of the detector is fed directly to the grid of V8-a, the afc (automatic frequency control) tube.

The plate of V8-a is connected through a 12-$\mu\mu$f capacitor to the hot end of the oscillator coil (L5). V8-a's plate circuit appears as a variable reactance across the oscillator tank coil. This reactance is controlled by the dc voltage developed by the discriminator and fed to the afc grid. If the oscillator drifts off frequency, the intermediate frequency changes and a positive or negative voltage is developed at the discriminator output. This error voltage is of the proper polarity and magnitude to cause the afc tube to swing the oscillator back to the correct frequency.

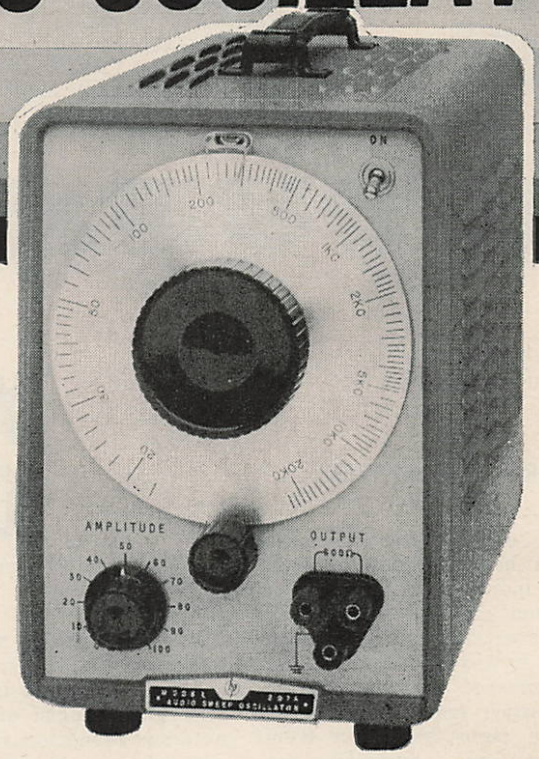
The B-plus power supply is transistorized with a 2N419 transistor oscillator in place of the more conventional vibrator. The oscillator operates at approximately 400 cycles. Potentiometer R32 controls the transistor current. The voltage developed across the secondary of the power transformer (T6) is rectified by a selenium rectifier and filtered to deliver 75 volts to the tuner's B-plus line. A varistor is used as a bleeder and voltage regulator to maintain the plate and screen voltages at the optimum level and to minimize changes in the oscillator frequency with changes in the battery voltage.

Installation precautions

Before installing the tuner or connecting it to a primary power source, turn R32 fully counterclockwise. Connect the positive side of a 14.4-volt dc source to the A-plus lead (P9) and the negative side to the chassis. Set S1 to AM and let the tuner warm up for several minutes. Adjust the supply voltage to exactly 14.4.

Set a vtvm to its 100-volt dc range and connect the positive test lead to the lug on the top of varistor R34 (the B-plus line) and the negative test lead to the chassis. Carefully turn R32 clockwise until the meter reads exactly 75 volts. *Do not overshoot 75 volts or the transistor may be damaged by excessive current. Be careful when adjusting R32. Its case is above chassis potential and any short from case to chassis, even momentary, will damage the transistor.* END

New kind of AUDIO OSCILLATOR



A push-pull audio sweep generator — Hewlett-Packard model 207A — derived from the familiar Wien-bridge circuit covers 20-20,000 cycles in a single band

By ROBERT F. SCOTT
TECHNICAL EDITOR

NEARLY all sine-wave audio signal generators are R-C types and most use the time-tested Wien bridge as the frequency-determining element. This article discusses the Hewlett-Packard model 207A audio sweep generator covering 20 to 20,000 cycles in one sweep of the tuning dial and shows how it evolved from the basic Wien-bridge oscillator.

The 207A is a balanced R-C type oscillator with a 1,000-to-1 tuning ratio covering the audio spectrum from 20 to 20,000 cycles in a single band. (This is quite an innovation when compared to the average R-C type generator with its 10-to-1 tuning ratio requiring three bands for the same coverage.) It is especially useful for measuring response of amplifiers, speakers, transformers and other audio components. The tuning-dial shaft extends through the rear of the cabinet and may be fitted with a reversing type motor for scanning the audio spectrum automatically. Also, an accessory potentiometer (type 207A-15) may be ganged to the shaft and connected to an external dc source to supply a voltage proportional to the logarithm of the frequency. This voltage may be used to drive a recorder or to supply horizontal deflection voltage to an oscilloscope to trace the response of the unit under test. The oscillogram shows the type of response pattern that may be made on an amplifier or similar device.

The circuit of the 207A is shown in Fig. 1.

Basic Wien-bridge oscillator

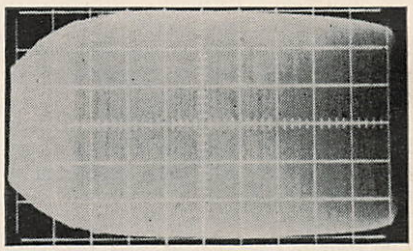
The basic circuit of the garden-variety Wien-bridge oscillator is shown in Fig. 2. Fundamentally, the circuit consists of an amplifier providing 360° phase shift with positive feedback from its output to the input through a frequency-selective Wien bridge. The selective network, R1–C1 and R2–C2, acts as a voltage divider supplying one-third the total output voltage to the grid of the first stage of the amplifier. The circuit oscillates at a frequency F_o where phase shift through the network is zero and $E_{feedback}/E_{output}$ equals ⅓ (see Fig. 2).

The frequency F_o of oscillation is determined from the equation:

$$F_o = \frac{1{,}000{,}000}{2\pi RC}$$

where F_o is in cycles, R in megohms and C in micromicrofarads. The frequency-determining networks are generally tuned by a dual-section variable capacitor substituted for C1 and C2 with the various ranges selected by switching in matched resistors for R1 and R2.

The tuning capacitor generally has a capacitance ratio of 10 to 1. Fig. 3 shows that as C is tuned through its range, its reactance X_c varies through a 10-to-1 ratio—as indicated by the shaded area—and frequency variation for each range is also 10 to 1.



Oscillogram produced by the model 207A.

Resistive network R_f–R_L (Fig. 2) is connected as a voltage divider supplying a negative feedback voltage to the cathode of the amplifier's input stage. R_L is generally a tungsten filament lamp whose resistance increases with current through it. When network R_f–R_L is properly proportioned, R_L varies the amount of negative feedback, keeping the amplifier's output constant and minimizing distortion.

The thermal time constant of R_L is one of the principal factors that determine the lowest frequency at which the circuit will oscillate satisfactorily. The total current through the lamp (R_L) consists of the direct cathode current, the ac component of the cathode current and the ac signal fed back through R_f. The two ac components are equal in frequency and phase and may be combined. When the frequency of oscillation is low and approaches the thermal time constant of the lamp, R_L's resistance tends to vary at the

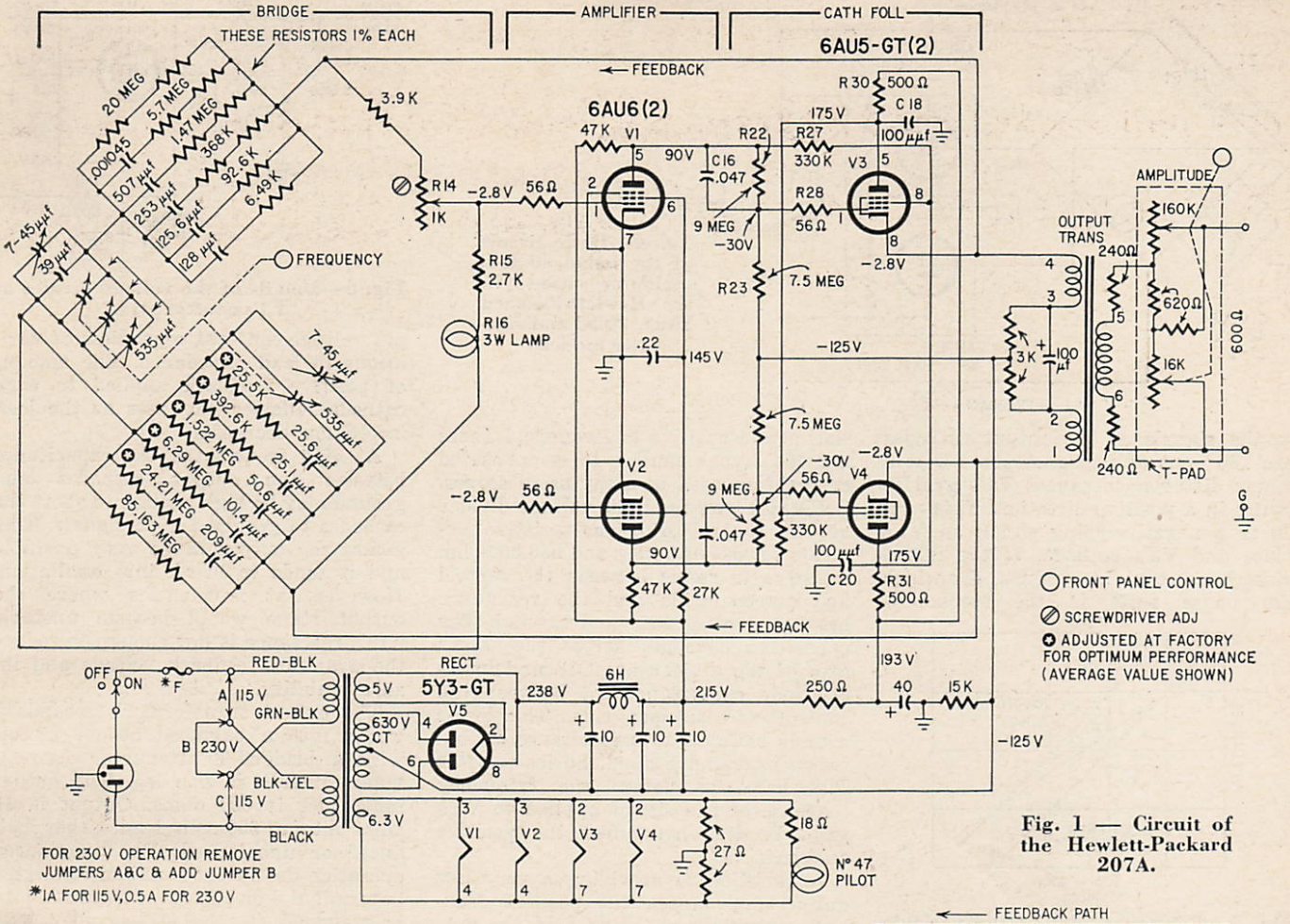


Fig. 1 — Circuit of the Hewlett-Packard 207A.

fundamental frequency. This periodic variation in amplifier gain produces unwanted harmonics in the output.

As the frequency decreases, the impedances in the frequency-determining networks increase. On the lower ranges C2's insulation resistance must be much higher than R2's resistance.

Balanced R-C oscillator

Fig. 4 is the basic circuit of the balanced R-C oscillator used in the Hewlett-Packard 200J, 202C and similar models. Here we have two balanced amplifiers fed from a floating bridge and each supplying 180° phase shift. The outputs of amplifiers A and B are 180° out of phase. Note that in this case, C1 and C2 are not equal—C1 equals 2C2 and R2 equals 2R1—and network impedances Z1 and Z2 are equal.

R_f and R_L are selected so R_f is slightly greater than R_L when the circuit is oscillating and delivering normal output. The input grid of amplifier A will be driven by a small fraction of amplifier B's output. The output of amplifier B is in phase with the normal signal on A's grid so A's output tends to increase. The increase in A's output increases the positive feedback voltage applied to amplifier B. Thus, both amplifiers are excited by positive feedback voltages, and oscillations are sustained.

In this balanced circuit, there is no dc flow through lamp R_L and the circuit oscillates satisfactorily at half the frequency that can be obtained with the same thermal time constant with dc in the circuit.

Another advantage of the balanced oscillator is that it does not place such stringent requirements on C2's insulation resistance. In the single-ended circuit (Fig. 2) the voltage across C2 is one-third the output voltage. In the balanced circuit (Fig. 4) the voltage across C2 is no higher than $E_{out}/2\mu$, where μ is amplifier gain. In this application μ is around 50. Thus the voltage across C2 is reduced by a factor $3/2\mu$ and the leakage current in C2's insulation resistance is only about 3% of that in a similar single-ended circuit, greatly improving operation.

Hewlett-Packard 207A

The circuit of the 207A in Fig. 1 is basically the same as the balanced Wien-bridge oscillator in Fig. 4. However, resistive elements R1 and R2 have been replaced by complex impedances composed of parallel networks of resistors and capacitors in series. The frequency-determining impedance elements in the variable arms of the bridge each have an impedance slope of *minus* ⅔. As the tuning capacitor is rotated through its range, the reactance varies from X_c to $10X_c$ and the oscillator covers a tuning range of 1,000 to 1 as shown in Fig. 5.

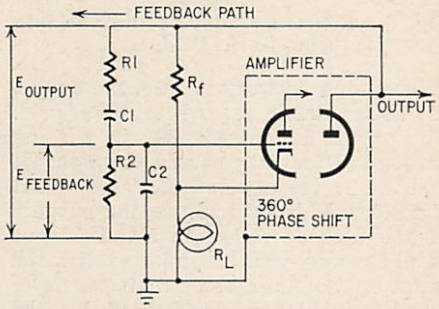


Fig. 2—Basic Wien-bridge oscillator circuit.

In Fig. 1, the oscillator consists of push-pull amplifiers V1 and V2 and cathode followers V3 and V4. V1's grid is fed from the junction of R14 and R15 on the resistive voltage-divider arms of the bridge and V2's grid is coupled to the junction of the frequency-determining arms.

The circuit is push-pull throughout

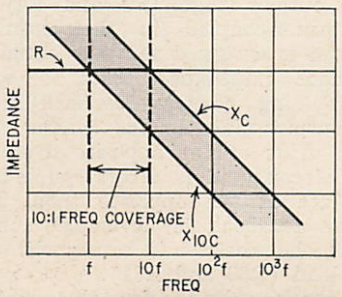


Fig. 3—Reactance plot of one R-C pair in a basic R-C oscillator.

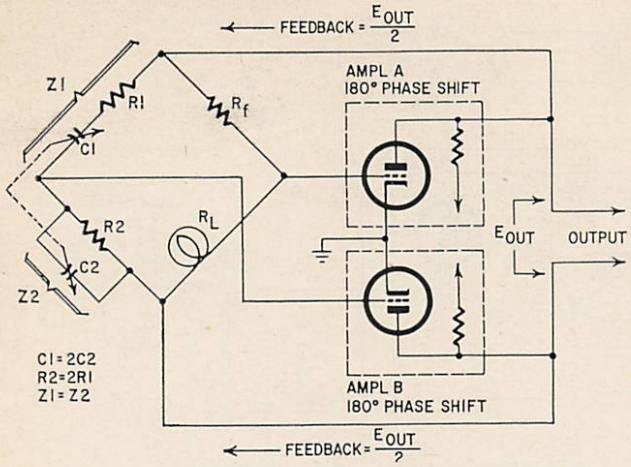


Fig. 4—Basic circuit of the balanced R-C oscillator used in the Hewlett-Packard 200J, 202C and similar models.

so the signals at the output cathodes are 180° out of phase. Assume that a minor disturbance causes V1's grid to swing in a positive direction. This produces a negative-going signal on V1's plate and V3's cathode. If the initial disturbance contains a signal for which the phase shift in the frequency-determining network is zero, the output of V3's cathode is fed to V2's grid. This signal is shifted 180° in passing through V2 and is passed through V4 and the bridge to reinforce the original signal on V1's grid. Since the outputs of the cathode followers are 180° out of phase and each amplifier excites the input of the other, the circuit oscillates at the frequency determined by the tuned network in the bridge.

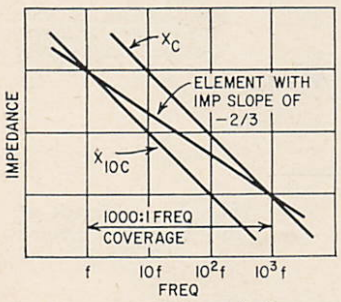


Fig. 5—Reactance plot of the variable arms in the bridge.

The amplitude of the output signal is stabilized against variations in operating voltages and tube characteristics by negative feedback voltages developed across the resistive arms of the bridge. Any unbalance in the output of the cathode followers increases or decreases the amount of feedback on V1's grid, varying the tube's output in the direction of balance.

The output stage (V3 and V4) is transformer-coupled to the external load and is designed for zero cathode-to-cathode impedance. This is done by providing positive feedback from each output plate to the control and screen grids of the opposite member. Each screen grid is direct coupled to the plate of the opposite tube. The positive feedback is developed across the 500-ohm resistor in series with the plate lead (R30 and R31).

Feedback voltage for the control grids is applied across voltage dividers that are insensitive to frequency. These are R-C types similar to compensated attenuators used in many oscilloscopes.

Fig. 6 shows the basic voltage divider at V3's control grid. The resistive elements consist of 9-meg and 330,000-ohm resistors in series between the control and screen grids and the resistance between control grid and ground. The capacitive elements across the upper arm of the divider are C16 and interelectrode capacitance C_{gs} between the control and screen grids. The lower arm is shunted by capacitance C_g between grid and ground. Series resistor R28 helps to flatten the frequency response of the signal applied to V3's grid. It does not affect the positive feedback.

In addition to providing a very low output impedance, this positive feedback network also helps hold the output voltage constant regardless of variations in load impedance. The amount of positive feedback applied to each cathode follower increases as the load impedance decreases.

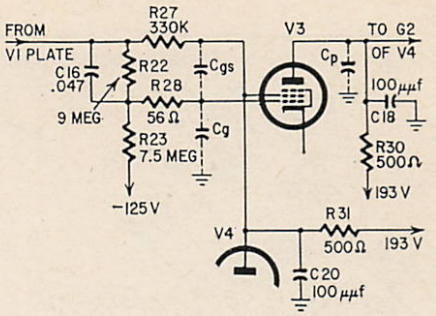


Fig. 6—Details of the voltage divider at V3's control grid.

At high frequencies, the capacitance between the output cathodes and ground may be high enough to short the cathodes to ground for ac signals. This makes the output stage very unstable and it tends to break into oscillation. However, at frequencies where the output stage would become unstable C18's reactance is low enough to reduce the available feedback voltage and insure stability.

The output transformer's secondary works into a balanced output circuit with a bridged-T attenuator (AMPLITUDE control) in one leg. The output impedance is 600 ohms. Output is 10 volts into a 600-ohm load either balanced or unbalanced. For unbalanced operation the output terminal connected to terminal 6 on the output transformer is grounded. END

Sweet Sounding Words . . .

are all right in their place. But when it comes to buying tubes by mail make sure the words are clear and to the point! When you buy from RADIO-ELECTRONICS mail order tube advertisers you don't have to worry. Since the January 1956 issue we have insisted that advertisers tell you that their tubes are new and unused—or that they are seconds, rejects or imperfect if that's the case. You need not be afraid of being taken in by sweet sounding words.

SIMPLE SUPER TIME BASE

An external triggered-sweep generator you can use with any oscilliscope

By TOM JASKI

A SIMPLE inexpensive way to extend the usefulness of your oscilloscope is to add a triggered sweep. If you have a medium-price scope, particularly a late-model kit, modifying the scope itself is not an easy job, even after you figure out what must be done. Most of them now use printed circuits, and monkeying with the printed boards is inviting trouble.

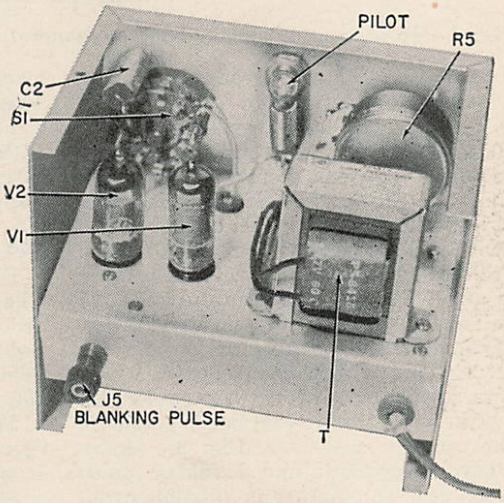
A more sensible approach is to build an external sweep generator which can be triggered. Some of these have appeared before (see "Delay and Timing Generator," RADIO-ELECTRONICS, September, 1956, page 50). Although adequate, a lot of them are complicated instruments which you might hesitate to build unless you expected to use them a lot.

Here is a simple version of a sweep generator which has all the important characteristics of the more complicated ones, uses only two tubes and is easy to build. The generator will sweep repetitively or by trigger, with sweep speeds of about 0.2 second up to 0.2 μsec per inch, with repetition rates ranging from 1 every 5 seconds to 1,000,000 per second. The sweep is almost perfectly linear over this tremendous range. The generator also provides blanking pulses and can be triggered by as little as 15 volts peak.

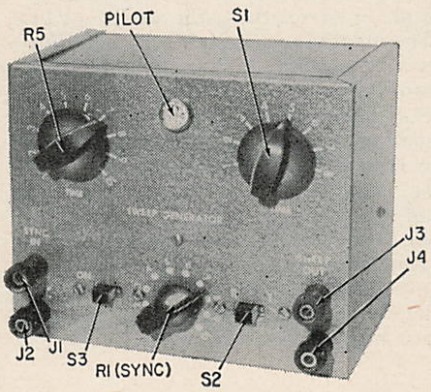
The sweep generator is useful wherever you need a single sweep. For example, in ignition analysis with your scope (RADIO-ELECTRONICS, September, 1957, page 46), you want to trigger the generator for each ignition pulse on one spark plug. To do this use the hookup shown in Fig. 1. The input from the breaker points is fed to the oscilloscope through a 100,000-ohm resistor, and with a 100-μμf capacitor across the scope's input. This setup provides the same patterns as the ignition analyzer if you are careful to set the generator sweep time to a value approximately four times as fast as the trigger pulses come in, or six or eight times, depending on the number of cylinders you want to observe.

Another use is in photographing transients. The trigger which starts the generator should come the same instant the transient starts and the entire transient will be swept, if the sweep speed is the same length as the duration of the transient or a little longer.

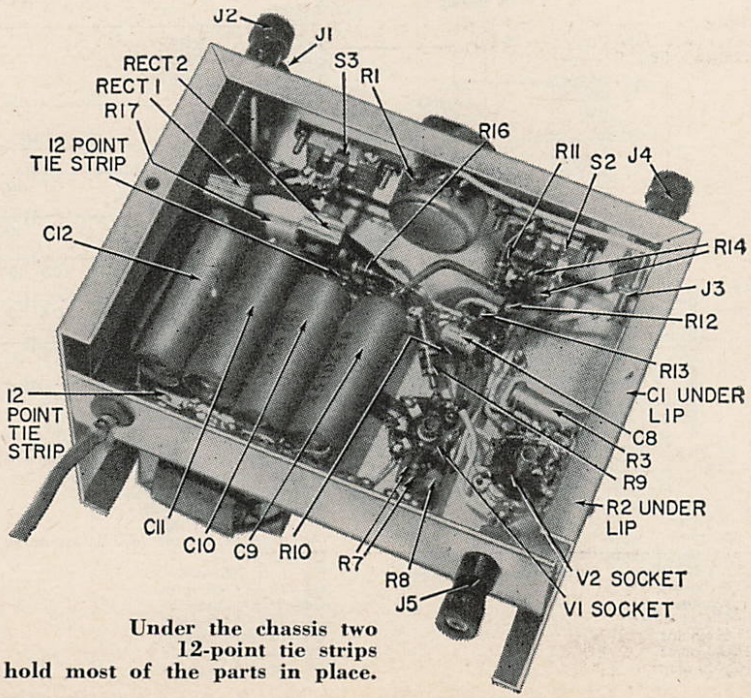
Even for normal repetitive sweep the little generator is convenient. Its range is greater than that of sweep generators in most scopes, its linearity is a little better, it synchronizes quite well, has no jitter, has a good blanking pulse and



Top-chassis view. Note the blanking-pulse output on the rear apron.



Closeup of the sweep generator.



Under the chassis two 12-point tie strips hold most of the parts in place.

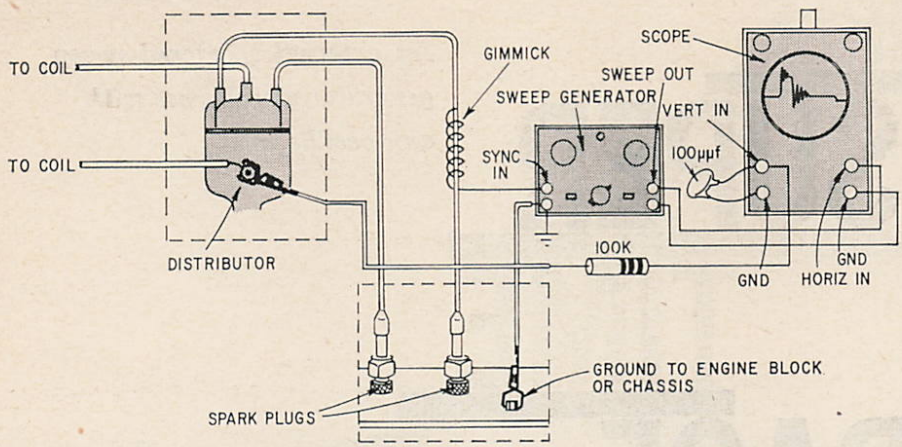


Fig. 1—How to use triggered sweep generator and scope for ignition analysis.

a high sweep-voltage output.

Sweep output is about 70 volts peak to peak and the blanking pulse is nearly 100 volts peak. Exact trigger voltage required depends somewhat on the shape of the trigger. If the trigger is a very short sharp spike, a fairly high peak will be required, maybe on the order of 50 volts negative. If the trigger is about 5% of the sweep duration, 25 volts will ensure reliable triggering. My generator has triggered on as little as 12 volts with a square pulse which was about 10% of the sweep length.

The generator is extremely stable as the oscillograms show. Fig. 3-c shows 20-cycle sawtooth and blanking pulse combined. The picture is a double exposure. No electronic switch was used!

The generator also has some limitations. No pulse-shaping circuitry is included so, if you want only a single sweep per trigger, the trigger pulse must be of the proper size and duration. The sweep output is directly connected to the phantastron oscillator, so the generator's output must not be loaded, unless we are willing to forego sweep-time calibration.

But in spite of these limitations, this little job is one of the most useful instruments on my bench. You'll be happy with it too.

The circuit

Fig. 2 shows the complete circuit. The synchronizing or trigger input is fed to the cathode of V2-a, which is used as a clamping diode. Plate and grid are both connected to the plate of the phantastron tube, the 6BH6 (V1).

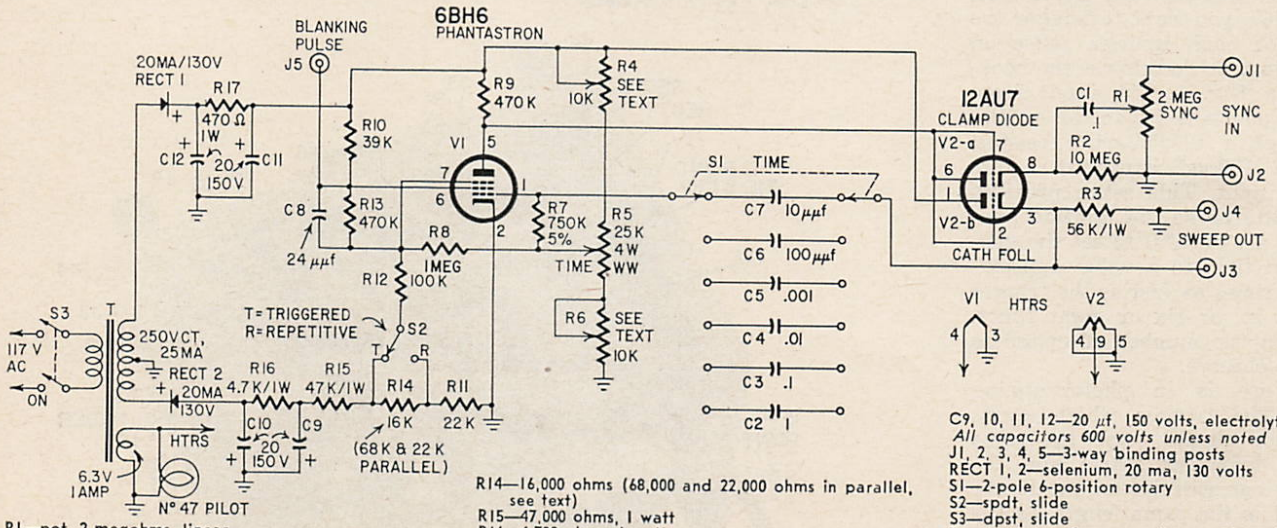
The phantastron circuit is not difficult to understand. Briefly here's how it works:

The suppressor grid is negative with respect to cathode because of the negative bias voltage applied through R12. This negative voltage keeps electrons from traveling to the plate, and the total cathode current is carried by the screen grid. This screening effect can be overcome by either a positive trigger pulse to the suppressor grid, making it less negative, or by a negative trigger pulse to the plate, making it momentarily less positive. We use the negative pulse here. It requires a larger trigger, but is easier to control than a sweep initiated by a suppressor trigger.

If you want both, you can add a binding post for positive triggers. Momentarily allowing the plate to carry current decreases the screen current. This lets screen voltage rise sharply. Since the screen is coupled to the suppressor through R13, the rising screen voltage carries the suppressor with it to almost 0 volts.

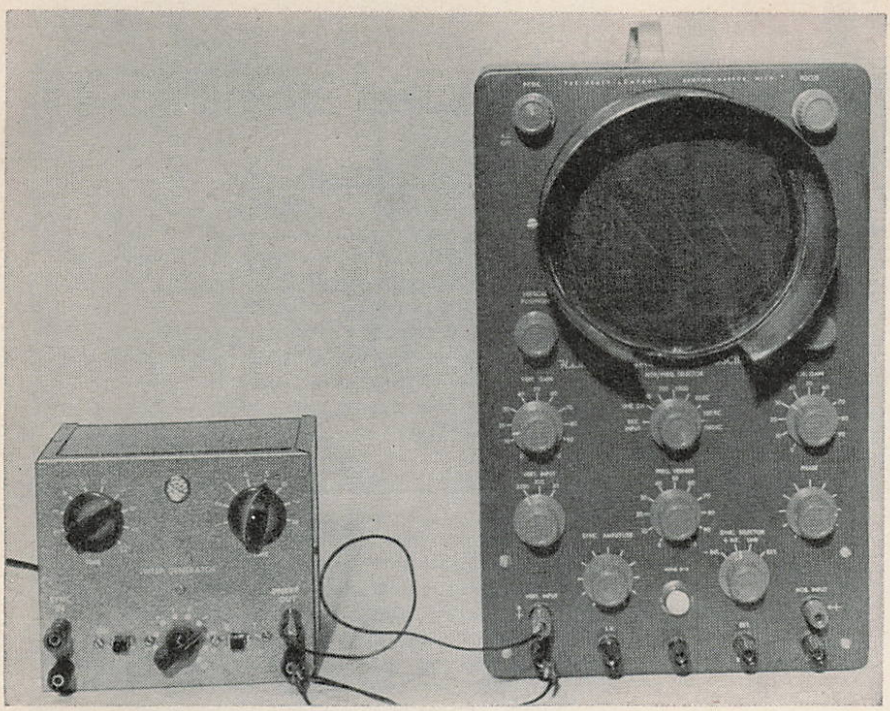
The plate can now continue to conduct. Plate voltage drops steadily to about 15. The plate of the 6BH6 (V1) is directly connected to the grid of V2-b, which is a cathode follower. At the point where V1's plate voltage is lowest (it is in fact lower than the cathode voltage of the cathode follower) this tube cuts off. The timing capacitor (C2 to C7) which was charged by the voltage on the cathode-follower cathode begins to discharge through R7, R8 and R12, at a rate set by the values of these resistors and R5's slider. The action of V1's grid insures that the discharge goes on at a steady rate. If the current increases too rapidly, the grid will become more negative, lowering the plate current, raising the plate voltage and the grid voltage on the cathode follower somewhat, and so on. Eventually when the capacitor is almost entirely discharged, V1's grid is sufficiently negative to almost cut it off, and the charge on C8 gives the final kick that does cut it off, until the next trigger arrives.

For repetitive operation the voltage on the suppressor is made not quite negative enough to cut off the plate entirely, and the tube will then go into action spontaneously. If you want to control the repetition rate separately,



R1—pot, 2 megohms, linear
R2—10 megohms
R3—56,000 ohms, 1 watt
R4, 6—pot, 10,000 ohms, linear (optional, see text)
R5—pot, 25,000 ohms, 4 watts, wirewound, linear
R7—750,000 ohms, 5%
R8—1 megohm
R9, 13—470,000 ohms
R10—39,000 ohms
R11—22,000 ohms
R12—100,000 ohms
R14—16,000 ohms (68,000 and 22,000 ohms in parallel, see text)
R15—47,000 ohms, 1 watt
R16—4,700 ohms, 1 watt
R17—470 ohms, 1 watt
All resistors ½-watt 10% unless noted
C1—0.1 μf
C2—1 μf, 200 volts
C3—0.1 μf, 200 volts
C4—.01 μf, ceramic
C5—.001 μf, ceramic
C6—100 μμf, ceramic
C7—10 μμf, ceramic
C8—24 μμf, ceramic
C9, 10, 11, 12—20 μf, 150 volts, electrolytics
All capacitors 600 volts unless noted
J1, 2, 3, 4, 5—3-way binding posts
RECT 1, 2—selenium, 20 ma, 130 volts
S1—2-pole 6-position rotary
S2—spdt, slide
S3—dpst, slide
T—power transformer: primary, 117 volts; secondary 250 volts ct, 25 ma; 6.3 volts, 1 amp (Stancor PS-8416 or equivalent)
V1—6BH6
V2—12AU7
Cabinet, 6 x 5 x 4 inches
Chassis, to fit cabinet
Socket, 7-pin miniature
Socket, 9-pin miniature
Pilot-lamp assembly with No. 47 lamp
Miscellaneous hardware

Fig. 2—Circuit of the 2-tube unit.



Simple Super Time Base hooked up to scope and ready to use.

use a potentiometer for R12.

However, this adds another control, and the design was worked out to allow continuous repetitive operation at one point, selected by switch S2. This, in the trigger (T) position holds the tube just below the point where it can act spontaneously. You will note that I had to parallel two resistors to make R14. This is the resistor which provides the difference in bias between triggered and repetitive operation. It may be best to adjust this value to exactly what is required for the tube you use. There may be a slight difference in tubes. If the tube refuses to be cut off at approximately these values however, you may have a gassy one. Try another.

From this discussion you can also see that the voltages at the ends of R5 determine the sweep rate to the extent that they affect the voltage of the slider on R5. Thus, by adjusting R4, you can adjust exactly the lowest speed for potentiometer R5, and with R6 the highest speed. These two pots (if included) should be 10,000 ohms each.

Again for the sake of simplicity, I left them out of my generator, because the 25,000-ohm pot provides well over a 10-to-1 sweep ratio, and calibration was not too important to me.

The "kick" given by capacitor C8 to the suppressor is, of course, a negative pulse and it comes exactly at the end of the rundown. Thus it is just right for a blanking pulse and we use it for that purpose. Again we must specify that this connection does not allow us to load the circuit—the blanking pulse must be isolated or fed into a very-high-impedance circuit. On my scope I can connect it directly to the blanking terminal, and it does a fine job without affecting the sweep speed materially.

The results of the circuit are obvious from the oscillograms. Figs. 3-a and 3-b show the sweep and the blanking pulse, respectively, at 650 kc. This is a very acceptable linearity at that frequency. Fig. 3-c shows the sweep and blanking pulse superimposed at 20 cycles, and again you will notice the linearity of the trace.

Fig. 3-d appears to be nonlinear. There the generator was used to sweep the beam across the C-R tube face for 1 second, with a 60-cycle voltage on the vertical input. The nonlinearity is due to the scope's horizontal amplifier which was not designed to handle such a low frequency. With a dc horizontal amplifier this trace would remain linear.

Construction hints

Construction is entirely conventional. Two 12-point terminal strips were used to hold the parts rigidly and neatly. Switch S1 was prewired. All the capacitors are soldered into place and leads attached to the contacts. No unusual or special parts were used. The photos show the top and bottom of the chassis. The tie points provide a rigid mounting for the selenium rectifiers, the resistors and capacitors of the power supply and others as well. The blanking-pulse output was brought out to the rear to keep the front panel symmetrical and because it is the most convenient place. The lead from there to the scope rear is then out of the way.

Using the super time base

There are no difficulties in putting the unit into operation. The only juggling which may have to be done was mentioned: the exact value of R14 may vary a little. Leave this resistor out, and turn on the generator. Then with a potentiometer temporarily clipped in place of R14 determine the point where S2 just changes the sweep from repetitive to nonrepetitive. Disconnect your potentiometer, measure the resistance and put that same value in its place. An excellent trigger source for the generator is the Differentiating Amplifier described in the September, 1958, issue of RADIO-ELECTRONICS, page 100.

If you have included R4 and R6, remember that when you adjust one, the voltages on the other will be affected somewhat. The best procedure is to adjust one, either the upper or the lower limit, to approximately the desired range of sweep speeds. Then adjust the other one. If the first one adjusted is R6, as R4 is made smaller, R6 will also have to have a little less resistance, and vice versa. The exact amount cannot be stated here, it depends on the original setting of the first one to be adjusted.

As mentioned, if you do not insist on accurate calibration, leave R4 and R6 out. The generator works well enough without them.

The whole assembly shouldn't cost over $15, and most of us have a good many of the parts in our junkboxes and need to buy only a few items.

Whatever you spend on it, if you need a triggered sweep, this generator is about the most inexpensive and reliable way to obtain it. END

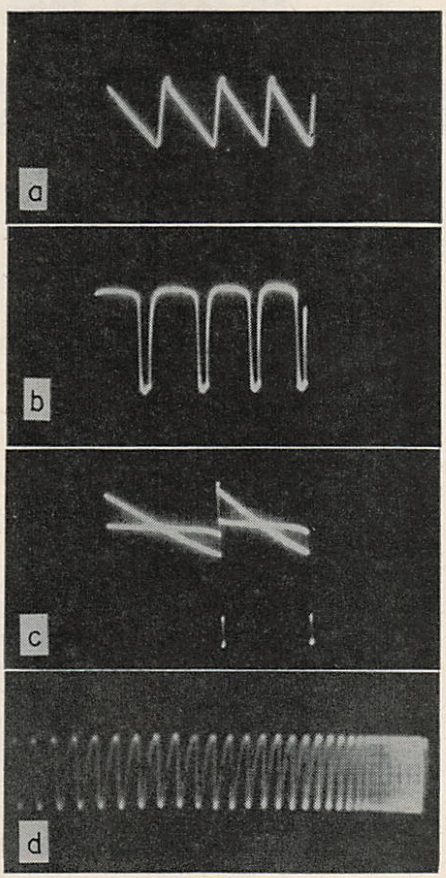
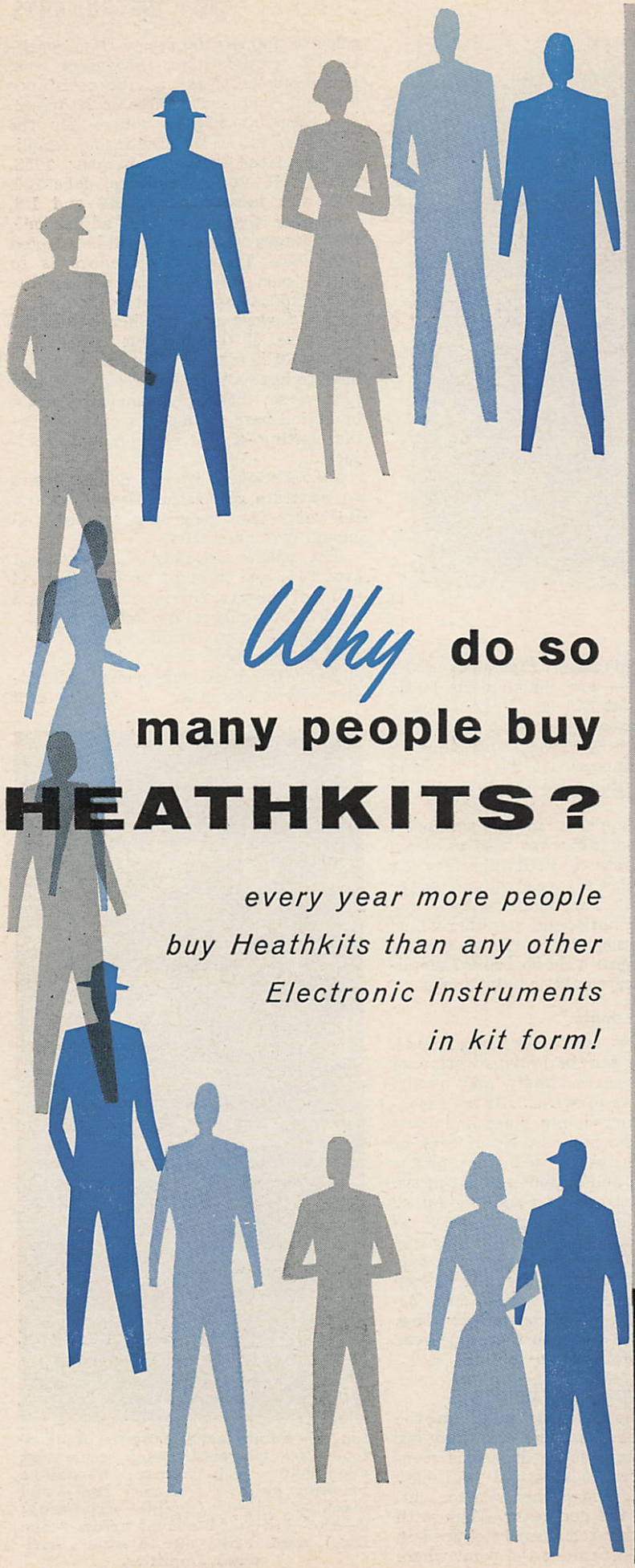


Fig. 3—Some scope patterns obtained from the triggered sweep generator; a—650-kc sweep voltage; b—650-kc blanking pulse; c—20-cycle sweep and blanking pulse (double exposure); d—slow sweep (1 second across scope face), nonlinearity due to scope's horizontal amplifier.



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EASY TO BUILD

Heathkits are engineered for easy kit construction. You need no electronic or kit building experience whatsoever to successfully complete your own kit. Use of printed circuit boards and pre-wired, pre-aligned assemblies cut construction time. Manuals are carefully prepared, employing step-by-step instructions written in simple, non-technical language. Large pictorial diagrams and photographs show you exactly where each part goes.

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A pioneer in do-it-yourself electronics, Heath Company, over more than a decade, has established public confidence in its products both in the United States and abroad. Today, as the world's largest manufacturer of electronic kits, Heath stands as the leader in its field.

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Do-it-yourself Heathkits save you up to ½ the cost of equivalent ready-made equipment. Direct factory-to-you selling, eliminating middle-man profit, plus the tremendous Heath purchasing power mean even further savings to you. And the convenient Heath Time Payment Plan allows you to use and enjoy your Heathkit NOW, while you pay for it in easy installments.

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Benton Harbor 20, Michigan

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TRANSISTOR PORTABLE RADIO KIT

Fun for the whole family, this easy-to-build 6-transistor portable radio is ready to go wherever you go. The modern molded plastic case with pull-out carrying handle and fully enclosed back add beauty and convenience to this splendid kit. Six name-brand (Texas Instrument) transistors are used for good sensitivity and selectivity. The 4″ x 6″ PM speaker with heavy magnet provides "big set" tone quality. Use of this large speaker and roomy chassis make it unnecessary to crowd components adding greatly to the ease of construction. Transformers are prealigned making the radio ready for use as soon as kit is assembled. A built-in rod-type antenna assures good reception in all locations. Six standard flashlight batteries are used for power, providing extremely long battery life (between 500 and 1,000 hours) and they can be purchased anywhere. Stylish cabinet is two-tone blue molded plastic with gold inlay and measures 9″ L. x 7″ H. x 3¾″ D. Shpg. Wt. 6 lbs.

MODEL XR-1L: Identical to XR-1P except in handsome leather case instead of plastic case. Leather carrying strap included. Shpg. Wt. 7 lbs.

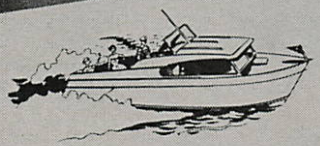
LEATHER CASE: Can be purchased separately if desired. Fits all XR-1P and earlier XR-1 chassis. No. 93-1. Shpg. Wt. 3 lbs. **$6.95.**

HEATHKIT MODEL XR-1P **$29.95**

MODEL XR-1L **$34.95**

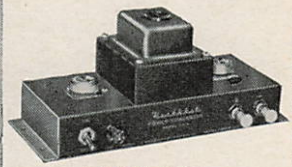
NAVIGATE BY PORTABLE RADIO

HEATHKIT MODEL DF-2 **$69.95**



2-BAND TRANSISTOR PORTABLE RADIO DIRECTION FINDER KIT

Enjoy the safety, convenience and entertainment of this self-contained, self-powered, six-transistor superheterodyne radio direction finder. It receives aeronautical and marine beacons as well as standard band broadcasts with startlingly clear tone reproduction over a long range. Covering the beacon band from 200 to 400 kc and broadcast band from 540 to 1620 kc, the DF-2 is designed to take directional "fixes" on both aircraft and marine beacons as well as standard broadcast stations, while providing the entertainment of a high quality transistor portable radio. You are able to receive aircraft weather reports every thirty minutes and constant Coast Guard beacons on the 200 to 400 kc band. A dial light is provided for night operation. Power is supplied by six standard flashlight batteries which will last you up to one year under normal operation. Shpg. Wt. 9 lbs.



MODEL PC-1 **$24.95**

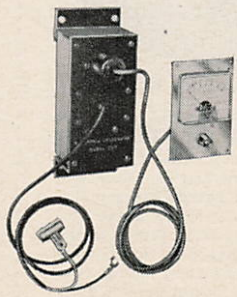
POWER CONVERTER KIT

Now you can operate your TV set, radio, razor, and other AC electrical equipment directly from your 12-volt boat or car battery. With the Heathkit Power Converter you can enjoy the convenience of home electricity whether boat cruising or on automobile trips. Two power transistors are employed for years of trouble-free, dependable service. No moving parts to wear out, no tubes to replace. Shpg. Wt. 8 lbs.

MODEL IA-1 **$59.95**

ELECTRONIC IGNITION ANALYZER KIT

Ideal for use on automobiles, boats, aircraft engines, etc., the IA-1 checks ignition systems with the engine in operation (400 to 5,000 RPM). Shows the condition of coil, condenser, points, plugs and ignition wiring. Shows complete engine cycle or just one cylinder at a time. Two test leads are supplied, each 10′ long, which will enable you to reach either the breaker points or the spark plug wires. Shpg. Wt. 20 lbs.



MODEL TI-1 **$25.95**

ELECTRONIC TACHOMETER KIT

Useful on inboard and outboard boats, as well as in automobiles, the TI-1 operates directly from the spark impulse of the engine. Use on any spark ignited 2 or 4 cycle engine of any number of cylinders. Completely transistorized, it works with 6, 8, 12, 24 or 32 volt DC systems. Indicates revolutions-per-minute from 0 to 6,000. Calibration control provided for adjusting to engine type. Easy-to-build and easy-to-install. Shpg. Wt. 4 lbs.

PROFESSIONAL OSCILLOSCOPE KIT

Everything you could possibly want in an oscilloscope is found in the new Heathkit model OP-1. Featured are DC coupled amplifiers and also DC coupled CR tube un-blanking. The triggered sweep circuit will operate on either internal or external signals and may be either AC or DC coupled. The polarity of the triggering signal may also be selected, and any point on the waveform may be selected for the start of the sweep by using the "triggering level" control. An automatic position is also provided, in which the sweep recurs at 50 cycle rate, but can be driven over a wide range of frequencies with no additional adjustment. Prewired terminal boards are used for rapid, easy assembly of all critical circuits. Power supply is transformer operated utilizing silicon diode rectifiers and is fused for protection. Handsome cabinet features silver anodized front panel with red and black lettering and matching knobs. Shpg. Wt. 34 lbs.

HEATHKIT MODEL OP-1 **$179.95**

VARIABLE VOLTAGE REGULATED POWER SUPPLY KIT

Invaluable in experimental and design work, the PS-4 eliminates the need for building up a separate power supply for each new circuit tried. It provides a convenient source of variable regulated B+, variable bias voltage and filament voltage for labs and work shops. The PS-4 supplies regulated B+ output continuously variable from 0 to 400 volts DC at up to 100 ma, bias voltage variable from 0 to —100 volts DC at 1 ma, and filament voltage of 6.3 volts AC at 4 amps. Separate panel meters continuously monitors voltage and current output. Rugged, top-rated components used throughout for long, reliable service. Shpg. Wt. 16 lbs.

HEATHKIT MODEL PS-4 **$54.95**

Your best dollar value...

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HEATH COMPANY • Benton Harbor 20, Michigan

a subsidiary of Daystrom, Inc.

TEST OSCILLATOR KIT

Provides the test frequencies most often used by servicemen in repairing and aligning modern broadcast receivers. Five fixed-tuned frequencies (262 kc, 455 kc, 465 kc, 600 kc and 1400 kc) are quickly selected for troubleshooting or alignment of the IF frequency and high and low end of the broadcast band for proper tracking. Shpg. Wt. 4 lbs.

HEATHKIT MODEL TO-1 **$16.95**

HEATHKIT MODEL O-12 **$65.95**

"EXTRA DUTY" 5" OSCILLOSCOPE KIT

Laboratory quality at utility scope price makes this instrument an unusual value. The Heath patented sweep circuit functions from 10 CPS to better than 500 kc in five steps, giving you five times the usual sweep obtained in other scopes. Vertical frequency response extends from 3 CPS to 5 mc +1.5 db —5 db without extra switching. An automatic sync circuit with self-limiting cathode follower provides excellent linearity and lock-in characteristics. Extremely short retrace time and efficient blanking action are characteristic of this scope. Frequency response of the horizontal amplifier is within ±1 db from 1 CPS to 200 kc. Horizontal sensitivity is 0.3 volts RMS-per-inch. Construction is simplified through the use of two etched metal circuit boards and precut, cabled wiring harness. Complete step-by-step instructions and large pictorial diagrams are supplied for easy assembly. An ideal scope for all service applications as well as in standard or color TV servicing. Shpg. Wt. 22 lbs.

MODEL SG-8 **$19.50**

RF SIGNAL GENERATOR KIT

A "must" for any beginning serviceman, this indispensable instrument is used for aligning tuned circuits quickly and tracing signals in faulty RF, IF and audio circuits. Covers 160 kc to 110 mc on fundamentals in five bands and from 110 mc to 220 mc on calibrated harmonics. Coils are prewound and calibrated. Complete with output cable and instructions. Shpg. Wt. 8 lbs.

MODEL AG-9A **$34.50**

AUDIO SIGNAL GENERATOR KIT

This unique generator uses three rotary switches to select two significant figures and a multiplier to determine audio frequency, allowing return to the exact frequency previously measured when making multiple frequency measurements. Covers 10 CPS to 120 kc with less than .1 of 1% distortion between 20 and 20,000 CPS. Shpg. Wt. 10 lbs.

MODEL TS-4A **$49.50**

TV ALIGNMENT GENERATOR KIT

TV service technicians will appreciate the outstanding features found in this sweep generator. Provides essential facilities for aligning FM, monochrome TV or color TV sets. The all-electronic sweep circuit employs a trouble-free controllable inductor which varies frequency by magnetic means. An unusual buy at this low price. Shpg. Wt. 16 lbs.

MODEL CD-1 **$59.95**

COLOR BAR AND DOT GENERATOR

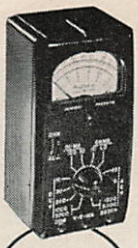
The CD-1 combines the two basic color servicing instruments, a color bar and white dot generator in one versatile and portable unit, which has crystal controlled accuracy and stability for steady lock-in patterns. (Requires no external sync leads.) Easy-to-build and easy-to-use. No other generator on the market offers so many features at such a great price saving. Shpg. Wt. 13 lbs.

ETCHED CIRCUIT VTVM KIT

Time proven for dependability, accuracy and overall quality, the V7-A is one of the wisest investments you can make for your electronic workshop or lab. Its multitude of uses will make it one of the most often used instruments in your possession. Use it to measure all operating voltages and potentials such as B+ and AC-DC, or straight AC power supplies, filament voltage, bias voltage, AVC voltage, line voltage, etc. Ideal for measurements in all types of AM, FM and TV circuits. Checks discriminator or detector operation, AVC or AGC performance, while the ohmmeter may be used to measure circuit continuity, circuit resistance, to test out individual components with resistance measurement, or to trace circuit wiring through cables or chassis openings. Front panel controls consist of rotary function switch and a rotary range selector switch, zero-adjust and ohms-adjust controls. Precision 1% resistors are used in the voltage divider circuit for high accuracy and an etched circuit board is employed for most of the circuitry. The circuit board not only simplifies assembly but permits levels of circuit stability not possible with ordinary conventional wiring methods. Shpg. Wt. 7 lbs.

HEATHKIT MODEL V7-A **$25.95**

HANDITESTER KIT



HEATHKIT MODEL M-1 **$17.95**

Ideal for use in portable applications when making tests away from the work bench or as an "extra" meter in the service shop. The combination function range switch simplifies operation. Measures AC or DC voltage from 0 to 10, 30, 300, 1,000 and 5,000 volts. Direct current ranges are 0 to 10 ma and 0 to 100 ma. Ohmmeter ranges are 0 to 3,000 and 0 to 300,000. Top quality, precision components used throughout. Small and compact, take it with you wherever you go. Very popular with home experimenters and electricians. Test leads and 1½ volt size C battery are included with the kit. Shpg. Wt. 3 lbs.

20,000 OHMS/VOLT VOM KIT

HEATHKIT MODEL MM-1 **$29.95**

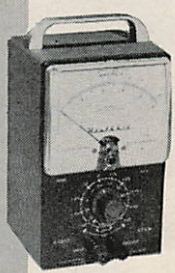
Portable and accurate, this kit features a 50 ua 4½" meter and 1% precision multiplier resistors for high accuracy. No external power required. Provides a total of 25 meter ranges on a two-color scale. Sensitivity is 20,000 ohms-per-volt DC and 5,000 ohms-per-volt AC. Measuring ranges are 0-1.5, 5, 50, 150, 500, 1,500 and 5,000 volts AC and DC. Measures direct current in ranges of 0-150 ua, 15 ma, 150 ma, 500 ma and 15 a. Resistance multipliers are X 1, X 100 and X 10,000. Covers —10 db to +65 db. Housed in an attractive bakelite case with plastic carrying handle. Batteries and test leads included. Shpg. Wt. 6 lbs.

TUBE CHECKER KIT

Brand new in every respect, the TC-3 features outstanding performance and ease of operation. Sockets are provided for 4-pin, 5-pin, 6-pin, 7-pin, large, 7-pin miniature, 7-pin sub-miniature, octal, loctal, and 9-pin miniature tubes. Protection against obsolescence is provided by a blank socket to facilitate modification for checking newly added tube types. A 10-lever switch makes it possible to connect any element to any other element regardless of the pin numbers involved. A neon bulb indicator shows filament circuit continuity and leakage or shorts between elements. A specially designed spring loaded roll chart mechanism permits the roll chart to run freely throughout its entire length without binding. Thumb wheel drive knobs are provided on both sides of the panel to accommodate the left handed operator. Compact and small in size, the TC-3 is ideally suited for portable applications. Both the roll chart and the meter are illuminated to facilitate use in darkened areas. Shpg. Wt. 12 lbs.

HEATHKIT MODEL TC-3 **$39.95**

AUDIO VTVM KIT



MODEL AV-3 **$29.95**

This vacuum tube volt meter emphasizes stability, broad frequency response and sensitivity for accurate measurement of critical AC voltages. Features a large 4½" 200 ua meter with increased damping in the meter circuit for stability in low frequency tests. Measures AC from a low value of 1 millivolt to a maximum of 300 volts AC (RMS). Voltage ranges are: 0-.01, .03, .1, .3, 1, 3, 10, 30, 100 and 300 volts. Db ranges cover —52 to +52 db. 1% precision multiplier resistors used for maximum accuracy. Frequency response is essentially flat from 10 CPS to 200 kc. Shpg. Wt. 6 lbs.

MODEL CT-1 **$7.95**

IN-CIRCUIT CAPACI-TESTER KIT

This handy kit checks capacitors for "open" or "short" right in the circuit. Detects open capacitors from about 50 mmf, not shunted by an excessive low resistance value. Checks shorted capacitors up to 20 mfd (not shunted by less than 10 ohms). Checks all bypass, blocking and coupling capacitors of the paper, mica or ceramic types. (Does not detect leakage nor check electrolytic condensers.) Electron beam "eye" tube is used for quick indication. A 5-position function switch is featured which controls the power to the instrument and selects the test being made. Easy to build and easy to use. Test leads included Shpg. Wt. 5 lbs.

MODEL BE-5 **$39.95**

LOW RIPPLE BATTERY ELIMINATOR KIT

Completely up to date the BE-5 will power all the newest transistor circuits requiring 0 to 12 volts DC, and the new hybrid automobile radios using both transistors and vacuum tubes. An extra low-ripple filter circuit is employed holding AC ripple down to less than .3%. Doubles as a battery charger or marine converter. Shpg. Wt. 21 lbs.

MODEL T-4 **$19.95**

VISUAL-AURAL SIGNAL TRACER KIT

New in every respect the T-4 features a built-in speaker and electron beam "eye" tube for signal indication, and a unique noise locator circuit. Ideal for use in AM, FM and TV circuit investigation. Transformer operated for safety and high efficiency. Complete with test leads and informative construction manual. Shpg. Wt. 5 lbs.

MODEL C-3 **$19.50**

CONDENSER CHECKER KIT

Check unknown condenser and resistor values quickly and accurately as well as their operating characteristics with this fine instrument. All values are read directly on a calibrated scale. An electron beam "eye" tube indicates balance and leakage. A valuable addition to any service shop or lab. Shpg. Wt. 7 lbs.

"APACHE" HAM TRANSMITTER KIT

HEATHKIT
MODEL TX-1
$229.50

- Modern Styling
- Rotating Slide Rule Dial
- Compact, Stable, VFO
- Provision for SSB Adapter

This beautifully styled transmitter has just about everything you could ask for in transmitting facilities. The "Apache" is a high quality transmitter operating with a 150 watt phone input and 180 watt CW input. In addition to CW and phone operation, built-in switch-selected circuitry provides for single-sideband transmission through the use of a plug-in external adapter. A completely redesigned, compact and stable VFO provides low drift frequency control necessary for SSB transmission. A slide rule type illuminated rotating VFO dial with full gear drive vernier tuning provides ample bandspread and precise frequency settings. The bandswitch allows quick selection of the amateur bands on 80, 40, 20, 15 and 10 meters (11 m with crystal control). This unit also has adjustable low-level speech clipping and a low distortion modulator stage employing two of the new 6CA7 /EL34 tubes in push-pull class AB operation. Time sequence keying is provided for "chirpless" break-in CW operation. The final amplifier is completely shielded for greater TVI protection and transmitter stability. A formed one-piece cabinet with convenient access hatch provides accessibility to tubes and crystal socket. Die-cast aluminum knobs and front panel escutcheons add to the attractive styling of the transmitter. Pi network output coupling matches antenna impedances between 50 and 72 ohms. A "spotting" push button is provided to allow tuning of the transmitter before switching on the final amplifier. This feature also enables the operator to "zero-beat" an incoming frequency without placing the transmitter on the air. Equip your ham shack now for top transmitting enjoyment with this outstanding unit. Shpg. Wt. 110 lbs.

$50.00 required on C.O.D. orders. Shipped motor freight unless otherwise specified.

New Styling...
New Features

HEATHKIT®

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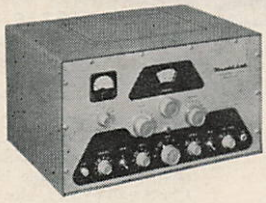
Benton Harbor 20, Michigan

a subsidiary of Daystrom, Inc.

HEATHKIT
MODEL SB-10
$89.95

SINGLE SIDEBAND ADAPTER KIT

Designed as a compatible plug-in adapter for the model TX-1 it can also be used with transmitters similar to the DX-100 or DX-100-B by making a few simple circuit modifications and still retain the normal AM and CW functions. Easy to operate and tune, the adapter employs the phasing method for generating a single sideband signal, allowing operation entirely on fundamental frequencies. The critical audio phase shift network is supplied, completely preassembled and wired in a sealed plug-in unit. Features include single-knob bandswitching for operation on 80, 40, 20, 15 and 10 meters, an easy-to-read panel meter, built-in electronic voice control with anti-trip circuit. Enjoy the advantages of SSB operation by adding this fine kit to your ham shack now. Shpg. Wt. 14 lbs.



MODEL
DX-100-B
$189.50

$50.00 deposit required on C.O.D. orders. Shipped motor freight unless otherwise specified.

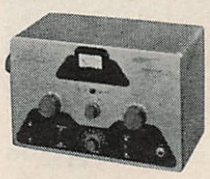
DX-100-B PHONE & CW TRANSMITTER KIT

The same fine performance of the time proven DX-100 is retained in the DX-100-B with improvements in the crystal and loading circuits. The one-piece formed cabinet has convenient access hatch for changing crystals, etc. and the chassis is punched to accept sideband adapter modifications. Features a built-in VFO, modulator and power supply, complete shielding to minimize TVI, and a pi network output coupling to match impedances from 50 to 72 ohms. RF output is in excess of 100 watts on phone and 120 watts on CW. Covers 160 through 10 meters. Single-knob bandswitching and illuminated VFO dial and meter face. RF output stage uses a pair of 6146 tubes in parallel, modulated by a pair of 1625's. Designed for easy assembly. Measures 11⅝" H. x 19½" W. x 16" D. Shpg. Wt. 107 lbs.

MODEL DX-40 **$64.95**

DX-40 PHONE & CW TRANSMITTER KIT

Operates on 80, 40, 20, 15, 11 and 10 meters, using a single 6146 tube in the final for 75 watt plate power input CW, or 60 watts phone. Single-knob bandswitching, pi network output, complete shielding, provision for three crystals and VFO. D'Arsonval movement panel meter. Shpg. Wt. 25 lbs.



MODEL DX-20 **$35.95**

DX-20 CW TRANSMITTER KIT

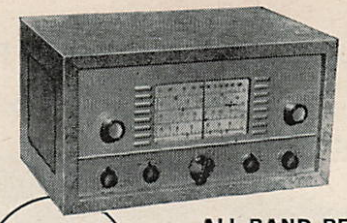
This fine unit covers 80, 40, 20, 15, 11 and 10 meters with single-knob bandswitching. Features a 6DQ6A tube in the final for 50 watt plate power input, pi network output, complete shielding to minimize TVI. Easy to build with complete instructions supplied. Shpg. Wt. 19 lbs.

"MOHAWK" HAM RECEIVER KIT

Designed for ham band operation and for maximum stability and accuracy, the Heathkit "Mohawk" receiver will let you enjoy ham activities to the utmost. This 15-tube receiver features double conversion with IF's at 1682 kc and 50 kc and covers all the amateur frequencies from 160 through 10 meters on seven bands. An extra band is calibrated to cover 6 and 2 meters using a converter. The "Mohawk" is specially designed for single-sideband reception with crystal controlled oscillators for upper and lower sideband selection. A completely pre-assembled, wired and aligned front end coil/bandswitch assembly assures ease of construction and top performance. Many more important features are provided in this outstanding receiver for dependable and effective amateur communications. Ruggedly constructed with well rated components throughout. Shpg. Wt. 66 lbs. Matching accessory speaker kit; optional extra. Model AK-5. $9.95. Shpg. Wt. 8 lbs.

- **Prewired and Aligned Coil/Bandswitch Assembly**
- **Crystal Controlled Oscillators for Drift-Free Reception**

HEATHKIT MODEL RX-1 **$274.95**



HEATHKIT MODEL AR-3 **$29.95**

(LESS CABINET)

ALL-BAND RECEIVER KIT

A fine receiver for the beginning ham or short wave listener. Frequency coverage is from 550 kc to 30 mc in four bands. Features include bandswitch, bandspread tuning, phone-standby-CW switch, antenna trimmer, noise limiter, RF and AF gain controls and headphone jack. Easy to build. Shpg. Wt. 12 lbs.

MODEL QF-1 **$9.95**

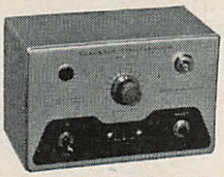
"Q" MULTIPLIER KIT

Use with any receiver with IF frequency between 450 and 460 kc to add additional selectivity for separating two signals or to reject one signal and eliminate heterodyne. A great help on crowded phone and CW bands. Not for use with AC-DC type receivers. Simple to connect with cable and plugs supplied. Shpg. Wt. 3 lbs.

"SENECA" VHF TRANSMITTER KIT

Brand new in every respect, the model VHF-1 "Seneca" is the latest addition to our line of ham transmitters. This self-contained 6 and 2 meter transmitter features built-in VFO, modulator, and dual power supply. A pair of 6146 tubes are employed in the push-pull final amplifier stage and features up to 120 watts input on phone and 140 watts input on CW in the 6 meter band. Slightly less in the 2 meter band to prolong amplifier tube life. Panel controls allow VFO or crystal control, phone or CW operation on both amateur bands. Four switch-selected crystal positions. Complete RF shielding to minimize TVI. Spotting push-button provided. The VFO slide rule type dial features edge-lighting and vernier tuning. An ideal transmitter for the ham who wants to extend operation into the VHF region. Shpg. Wt. 56 lbs.

HEATHKIT MODEL VHF-1 **$159.95**



MODEL CA-1 **$13.95**

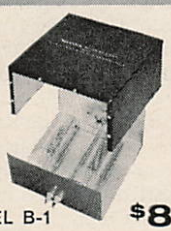
"AUTOMATIC" CONELRAD ALARM KIT

This easy-to-build device gives instant warning and cuts AC power to your transmitter when a monitored station goes "off-the-air". Use with any radio receiver having an AVC circuit. A sensitivity control adjusts to various AVC levels. Incorporates a heavy duty six-ampere relay and manual "reset" button to reactivate the transmitter. Complete instructions provided for connection to receiver. Shpg. Wt. 4 lbs.

MODEL AM-2 **$15.95**

REFLECTED POWER METER KIT

Check the match of your antenna transmission system by measuring the forward and reflected power or standing wave ratio from 1:1 to 6:1. Handles a peak power of well over 1 kilowatt and may be left in antenna feed line. No external power required. 160 through 6 meters. For 50 or 75 ohm lines. Shpg. Wt. 3 lbs.



MODEL B-1 **$8.95**

BALUN COIL KIT

Unbalanced coax lines can be matched to balance lines of either 75 or 300 ohms by using this balun coil kit. Use without adjustment from 80 through 10 meters at power up to 200 watts. May be located any distance from transmitter or antenna. Protective cover included. Shpg. Wt. 4 lbs.

MODEL VX-1 **$23.95**

ELECTRONIC VOICE CONTROL KIT

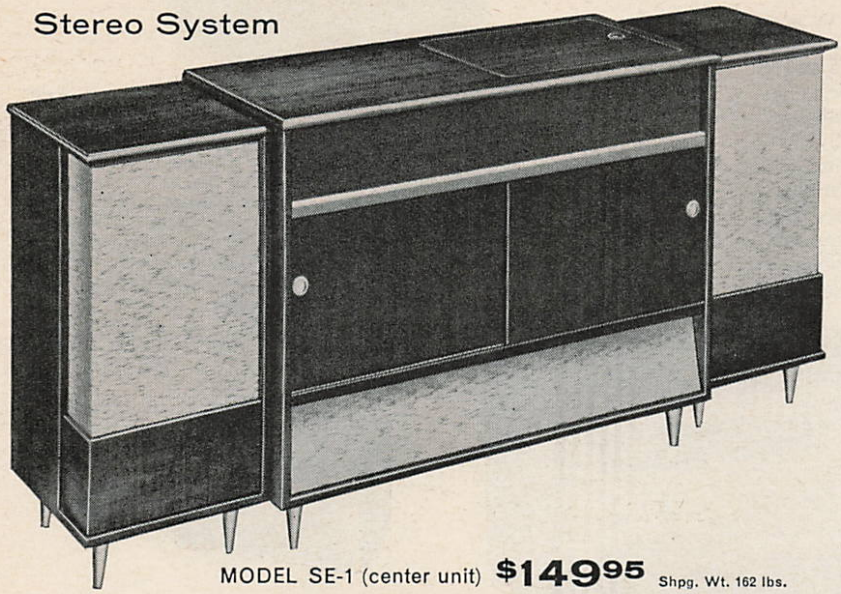
This unique device lets you switch from receiver to transmitter merely by talking into your microphone. Provision is made for receiver and speaker connections and also for a 117 volt antenna relay. Adjustable to all conditions by sensitivity and variable time delay controls provided. Shpg. Wt. 5 lbs.

MODEL VF-1 **$19.50**

VARIABLE FREQUENCY OSCILLATOR KIT

Far below the cost of crystals to obtain the same frequency coverage this VFO covers 160, 80, 40, 20, 15, 11 and 10 meters with three basic oscillator frequencies. Better than 10 volts RF output on fundamentals. Requires only 250 volts DC at 15 to 20 ma, and 6.3 VAC at 0.45 a. Illuminated dial reads direct. Shpg. Wt. 7 lbs.

Beautifully Styled With Plenty of Room For The Most Complete Stereo System



MODEL SE-1 (center unit) **$149.95** Shpg. Wt. 162 lbs.

MODEL SC-1 (speaker enclosure) **$39.95** each Shpg. Wt. 42 lbs.

STEREO EQUIPMENT CABINET KIT

This superbly styled cabinet ensemble is designed to hold your complete home stereo hi-fi system, consisting of a "stereo equipment center" flanked by two individual "stereo wing speaker enclosures". The unit has room for all the components required for stereo sound. Although designed to hold Heathkit stereo components, it is not frozen to this arrangement. The kit is supplied with mounting panels precut to accommodate Heathkits, but interchangeable blank panels are also furnished so you can mount any equipment you may already have. The precut panels accommodate the Heathkit AM-FM tuner (PT-1), stereo preamplifier (SP-1 & 2), and record changer (RP-3). Record changer chassis pulls out easily for convenient loading and unloading. Adequate space is provided for record storage and a pair of matching Heathkit power amplifiers (from 12 to 70 watts). The stereo wing speaker enclosures are open backed, cloth grilled cabinets designed to hold the Heathkit SS-2 or similar speaker systems. The cabinets are available in beautifully grained ¾" solid core Phillipine mahogany or select birch plywood suitable for the finish of your choice. The matched grain sliding tape deck access door on top pops-up flush when closed. Entire top features a shaped edge. Hardware and trim of brushed-brass and gold finish. Rich toned grille cloth is flecked in gold and black. No woodworking experience required. All parts precut and predrilled for easy assembly. Maximum overall dimensions (all 3 pieces): 82¾" W. x 36½" H. x 20" D. Center Cabinet: 47½" W. x 36½" H. x 20" D.

CHAIRSIDE ENCLOSURE KIT

Combine all of your hi-fi equipment into one compact control center and, at the same time add a beautiful piece of furniture to your home. The CE-1 is designed to house AM and FM tuners (BC-1A and FM-3A) and the WA-P2 preamplifier along with the majority of record changers which will fit in the space provided. Changer compartment measures 17¾" L. x 16" W. x 9⅜" D. Adequate space is provided in the rear of the unit to house any of the Heathkit amplifiers designed to operate with the WA-P2. Good ventilation is achieved through properly placed slots in the bottom and back of the enclosure. Overall dimensions are 18" W. x 24"H x 35½" D. All parts are precut and predrilled for easy assembly. The Contemporary cabinet is available in either mahogany or birch, and the Traditional cabinet is available in mahogany suitable for the finish of your choice. Beautiful hardware supplied. Shpg. Wt. 46 lbs.

Plan your own Hi-Fi System...

HEATHKIT®

HEATH COMPANY • Benton Harbor 20, Michigan

a subsidiary of Daystrom, Inc.

HIGH FIDELITY RECORD CHANGER KIT

Every outstanding feature you could ask for in a record changer is provided in the Heathkit RP-3, the most advanced changer on the market today. The unique turntable pause during the change cycle saves wear and tear on your records by eliminating the grinding action caused by records dropping on a moving turntable or disk. Record groove and stylus wear are practically eliminated through proper weight distribution and low pivot point friction of the tone arm. Clean mechanical simplicity and precision parts give you turntable performance with the automatic convenience of a record changer. Flutter and wow, a major problem with automatic changers, is held to less than 0.18% RMS. An automatic speed selector position allows intermixing 33⅓ and 45 RPM records regardless of their sequence. Four speeds provided: 16, 33⅓, 45 and 78 RPM. Changer is supplied complete with GE VR II cartridge with diamond LP and sapphire 78 stylus, changer base, stylus pressure gauge and 45 RPM spindle. Shpg. Wt. 19 lbs.

"BASIC RANGE" HI-FI SPEAKER SYSTEM KIT

The popularity of this modestly priced speaker system attests to its high fidelity performance. The SS-2 provides an ideal basic speaker for your home hi-fi system. Flexibility of design allows it to be used as a table top model or as an attractive consolette with optional legs. May also be used as a supplementary speaker in more advanced systems or as replacement speaker for TV sets, etc. The specially designed tweeter horn rotates 90 degrees allowing you to use the speaker in an upright position if desired, as in the Heathkit stereo wing speaker enclosures. Total frequency range is from 50 to 12,000 cycles-per-second. An 8" mid-range woofer covers from 50 to 1,600 CPS while a compression-type tweeter with flared horn covers 1,600 to 12,000 CPS. Both speakers are by Jensen. A variable balance control allows level adjustment of the high frequency speaker. Power rating is 25 watts. Constructed of ½" veneer-surfaced plywood suitable for light or dark finish. All wood parts are precut and predrilled for simple, quick assembly. An added feature of the SS-2 is that, although an outstanding performer in its own right, it may be combined with the SS-1B "range extending" speaker system later to extend the frequency range at the high and low ends of the audio range. Build in just one evening for many years of listening enjoyment. Shpg. Wt. 26 lbs.

ATTRACTIVE BRASS TIP ACCESSORY LEGS convert SS-2 into handsome consolette. 14" legs screw into brackets provided. All hardware included. Shpg. Wt. 3 lbs. No. 91-26. **$4.95.**

Assemble it in

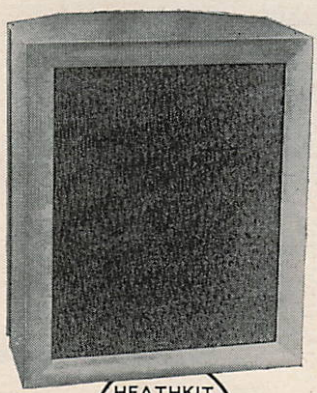
Just One Evening

OPTIONAL LEGS
NO. 91-26 **$4.95**

DIAMOND STYLUS HI-FI PICKUP CARTRIDGE

MODEL MF-1 **$26.95**

Replace your present pickup with the MF-1 and enjoy the fullest fidelity your library of LP's has to offer. Designed to Heath specifications to offer you one of the finest cartridges available today. Nominally flat response from 20 to 20,000 CPS. Shpg. Wt. 1 lb.



Extended Frequency Range for Your SS-2

"RANGE EXTENDING" HI-FI SPEAKER SYSTEM KIT

Designed exclusively for use with the SS-2, the SS-1B employs a 15" woofer and a super tweeter horn to extend the range of the SS-2 to an overall response of ±5 db from 35 to 16,000 CPS. When used together the two units form an integrated four-speaker system and are designed to combine into a single piece of attractive furniture. Impedance of the SS-1B is 16 ohms and power rating 35 watts. A control is provided to limit the output of the super tweeter. Constructed of beautiful ¾" veneer-surfaced plywood suitable for light or dark finish of your choice. All parts are precut and predrilled for simple assembly. No woodworking experience required. All hardware included. Shpg. Wt. 80 lbs.

"LEGATO" HI-FI SPEAKER SYSTEM KIT

It is difficult to describe in words the performance of this magnificent speaker system. You may never find absolute perfection in reproduced sound, but the Legato comes as close to achieving it as anything yet devised. Perfect balance, precise phasing, and adequate driver design combine to produce the superb quality of reproduction inherent in this instrument. The crisp, clear high frequencies and rich full bass engulf you in a sea of life-like tone. Two 15" Altec Lansing low frequency drivers cover frequencies from 25 to 500 CPS while a specially designed exponential horn with high frequency driver covers 500 to 20,000 CPS. The unique crossover network is built-in making electronic crossovers unnecessary. The legato emphasizes simplicity of line and form to blend with modern or traditional furnishings. Constructed of ¾" veneer-surfaced plywood in either African mahogany or white birch suitable for light or dark finishes of your choice. All parts are precut and predrilled for easy assembly. Shpg. Wt. 195 lbs.

Easy to buy...

Easy to build

Easy to use...

HEATHKIT®

HEATH COMPANY

Benton Harbor 20, Michigan

High Fidelity AM and FM reception in a Single Set

HEATHKIT MODEL PT-1 **$89.95**

Professional Stereo-Monaural AM-FM Tuner Kit

Enjoy stereophonic broadcasts as well as outstanding individual AM and FM radio reception with this deluxe 16-tube AM-FM-stereophonic tuner combination. Features include three etched circuit boards for high stability and ease of construction, prewired and prealigned FM front end, built-in AM rod antenna, tuning meter, FM-AFC (automatic frequency control) with on-off switch, and flywheel tuning. A multiplex jack is also provided. AM and FM circuits are tuned individually making it ideal for stereo applications since both AM and FM can be used at the same time. A switch selected tuning meter functions on either AM or FM. Cathode follower outputs with individual level controls are provided for both AM and FM. Other features include variable AM bandwidth, 10 kc whistle filter, tuned-cascode FM front end, FM AGC and amplified AVC for AM. Anywhere from 1 to 4 limiters or IF's assure smooth, non-flutter reception on weak or strong stations alike. The silicon diode power supply is conservatively rated and is fuse-protected assuring long service life. Flywheel tuning combined with new edge-lighted slide-rule dial provide effortless tuning. Use of three printed circuit boards greatly simplifies construction. Vinyl-clad steel cover is black with inlaid gold design. Shpg. Wt. 20 lbs.

MODEL FM-3A **$26.95**

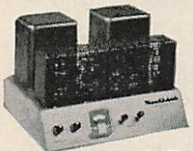
HIGH FIDELITY FM TUNER KIT

The Heathkit FM-3A Tuner will provide you with years of inexpensive hi-fi enjoyment. Features broad-banded circuits for full fidelity and better than 10 uv sensitivity for 20 db of quieting. Covers the complete FM band from 88 to 108 mc. Stabilized, temperature-compensated oscillator assures neglible drift after initial warmup. Employs a high gain cascode IF amplifier and has AGC. Power supply is built-in. IF and ratio transformers are prealigned as is the front end tuning unit. Two outputs provided, one fixed, one variable, with extra stage of amplification. Shpg. Wt. 8 lbs.

MODEL BC-1A **$26.95**

HIGH FIDELITY AM TUNER KIT

The BC-1A incorporates many features not usually expected in an AM circuit particularly in this low price range. It features a special detector using crystal diodes and broad band-width IF circuits for low signal distortion. Audio response is ±1 db from 20 CPS to 9 kc with 5 db of pre-emphasis at 10 kc to compensate for station rolloff. Covers the complete broadcast band from 550 to 1600 kc. Prealigned RF and IF coils eliminate the need for special alignment equipment. Incorporates AVC, two outputs, two antenna inputs and built-in power supply. Shpg. Wt. 9 lbs.



MODEL W-6 **$109.95**

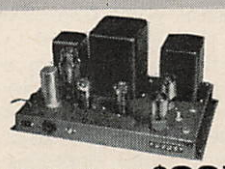
"HEAVY DUTY" 70 WATT HI FI AMPLIFIER KIT

Designed for "rugged duty" called for by advanced hi-fi systems and P.A. networks. Silicon diode rectifiers assure long life and heavy duty transformer provides excellent power supply regulation. Variable damping control provides optimum performance with any speaker system. Quick change plug selects 4, 8 and 16 ohm or 70 volt output and the correct feedback resistance. Shpg. Wt. 52 lbs.

MODEL W-5 **$59.75**

25 WATT HI FI AMPLIFIER KIT

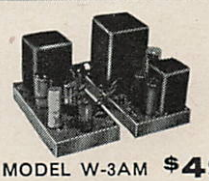
Enjoy the distortion-free high fidelity sound from one of the most outstanding hi-fi amplifiers available today. Features include a specially designed Peerless output transformer and KT66 tubes. Frequency response is ±1 db from 5 to 160,000 CPS at 1 watt and within 2 db 20 to 20,000 CPS at full 25 watts output. Hum and noise are 99 db below 25 watts. Shpg. Wt. 31 lbs.



MODEL W-4AM **$39.75**

SINGLE CHASSIS 20 WATT HI FI AMPLIFIER KIT

A true Williamson-type high fidelity circuit, the W-4AM features 5881 push-pull output tubes and a special Chicago-Standard output transformer to guarantee you full fidelity at minimum cost. Harmonic distortion is 1.5% and IM distortion is below 2.7% at full 20 watt output. Hum and noise are 95 db below full output. Taps for 4, 8 or 16 ohm speakers. Shpg. Wt. 28 lbs.



MODEL W-3AM **$49.75**

DUAL CHASSIS 20 WATT HI FI AMPLIFIER KIT

Another famous Williamson-type high fidelity circuit, the W-3AM features the famous Acrosound TO-300 "ultralinear" output transformer and 5881 tubes. The power supply and main amplifier are on separate chassis for installation flexibility. Harmonic distortion is less than 1% and IM distortion is less than 1.2% at 20 watts. Shpg. Wt. 29 lbs.

HEATHKIT
MODEL SP-2
(STEREO)
$56.95

Monaural-Stereo Preamplifier Kit (2-Channel Mixer)

This unique kit allows you to purchase it in the monaural model if desired and then add the second or stereo channel later. The SP-2 features 12 separate inputs, six on each channel, with input level controls. Six dual concentric controls consist of: two 8-position selector switches, two bass, two treble, two volume level and two loudness controls, a scratch filter switch and a 4-position function switch. A separate on-off switch is provided. The function switch provides settings for stereo, 2-channel mix, channel A or B for monaural use. Inputs consist of tape, mike, mag phono and three high-level inputs. NARTB equalization and RIAA, LP, 78 record compensation are provided. A remote balance control is included. Printed circuit boards for easy assembly. Built-in power supply. Shpg. Wt. 15 lbs.

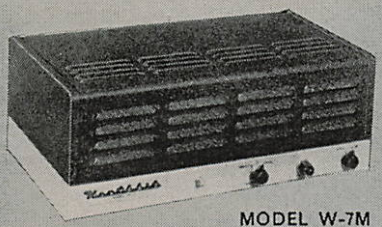
MODEL SP-1 (MONAURAL)
$37.95 Shpg. Wt. 13 lbs.

MODEL C-SP-1 (CONVERTS SP-1 TO SP-2)
$21.95 Shpg. Wt. 5 lbs.

HEATHKIT
MODEL WA-P2
$19.75

"MASTER CONTROL" PREAMPLIFIER KIT

Control your hi-fi system with this compact unit. Features 5 switch-selected inputs to accommodate a record changer, tape recorder, AM tuner, FM tuner, TV receiver, microphone, etc., each with level control. Provision also for a tape recorder output. Equalization for records through separate turnover and rolloff switches for LP, RIAA, AES and early 78's. Shpg. Wt. 7 lbs.



MODEL W-7M
$54.95

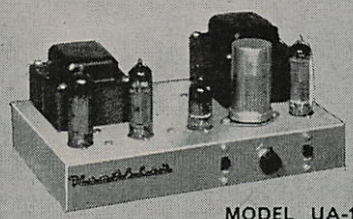
"EXTRA PERFORMANCE" 55 WATT HI FI AMPLIFIER KIT

Enjoy this high fidelity power amplifier at less than a dollar per watt. Full audio output and maximum damping is conservatively rated at 55 watts from 20 CPS to 20 kc with less than 2% total harmonic distortion throughout the entire range. Features famous "bas-bal" circuit, EL-34 output tubes and special 70 volt output. Shpg. Wt. 28 lbs.

MODEL XO-1
$18.95

ELECTRONIC CROSSOVER KIT

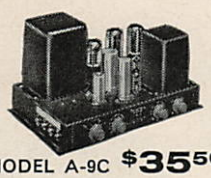
This unique instrument separates high and low frequencies and feeds them through 2 amplifiers into separate speakers. Located ahead of the main amplifier, it virtually eliminates IM distortion and matching problems. Note: Not for use with Heathkit Legato speaker system. Shpg. Wt. 6 lbs.



MODEL UA-1
$21.95

"UNIVERSAL" 12 WATT HI FI AMPLIFIER KIT

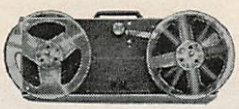
The versatility and economy of this fine kit make it a truly "universal" hi-fi amplifier. An ideal basic amplifier for any hi-fi system or a perfect addition to gear your present hi-fi system to stereo sound. Uses 6BQ5/EL84 push-pull output tubes for less than 2% harmonic distortion throughout the entire audio range. Shpg. Wt. 13 lbs.



MODEL A-9C **$35.50**

GENERAL-PURPOSE 20 WATT AMPLIFIER KIT

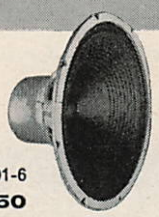
Designed for home installation as well as for PA requirements, the A9-C combines a preamplifier, main amplifier and power supply all on one chassis. Four switch-selected inputs are provided as well as separate bass and treble tone controls offering 15 db boost and cut. Detachable front plate allows for custom installation. Shpg. Wt. 23 lbs.



MODEL SW-1 **$24.95**

SPEEDWINDER KIT

A real timesaver, the SW-1 leaves your tape recorder free for operation while rewinding tape at the rate of 1200 feet in 40 seconds. Prevents unnecessary wear to the tape and recorder. Handles up to 10½" tape reels. Handles 800' reels of 8 and 16 millimeter film as well. Automatic shutoff prevents whipping at end of rewind. Shpg. Wt. 12 lbs.



NO. 401-6
$7.50

12" UTILITY SPEAKER KIT

Replace inferior speakers in radio or TV sets to obtain better tone quality or set up an auxiliary speaker for testing purposes with this convenient, high quality speaker. The speaker will handle up to 12 watts with a frequency response of ±5 db from 50 to 9,000 CPS. Speaker impedance is 8 ohms and has a 6.8 oz. magnet. An outstanding dollar value. Shpg. Wt. 7 lbs.

MODEL TK-1 **$9.95**

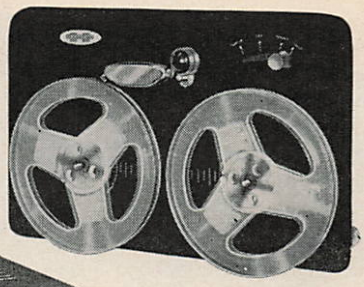
COMPLETE TOOL SET

These basic tools are all you need to build any Heathkit. The pliers, diagonal side cutters, 2 screwdrivers, and soldering iron are all of top quality case hardened steel for hard duty and long life. Pliers and side cutters are equipped with insulated rubber handles for safety. A good example of just how easy Heathkit building really is. Shpg. Wt. 3 lbs.

HIGH FIDELITY TAPE RECORDER KIT

The model TR-1A tape deck and preamplifier combination provides all the facilities you need for top quality monaural recording/playback with fast forward and rewind functions. 7½ and 3¾ IPS tape speeds are selected by changing belt drive. Flutter and wow are held to less than 0.35%. Frequency response at 7½ IPS ±2.0 db 50-10,000 CPS, at 3¾ IPS ±2.0 db 50-6,500 CPS. Both units may be mounted together or separately affording high flexibility in every application. Features include NARTB playback equalization —separate recording and playback gain controls —cathode follower output and provision for mike or line input. Signal-to-noise ratio is better than 45 db below normal recording level with less than 1% total harmonic distortion. A filament balance control allows adjustment for minimum hum level. Complete instructions provided for easy assembly. Overall dimensions of tape deck and preamp is 15½" W. x 13½" H. x 8" D. Shpg. Wt. 24 lbs.

HEATHKIT TR-1A
$99.95



Includes tape deck assembly, preamplifier and roll of tape.

HEATHKIT TE-1
$39.95

Tape preamplifier sold separately if desired. Shpg. Wt. 10 lbs.

Many more Heathkits to choose from

hi-fi: Amplifiers—Preamplifiers—Speaker Systems—AM/FM Tuners—Equipment Cabinets—Record Player—Tape Recorder—Electronic Crossover—Stereo Equipment.

test: Oscilloscopes—Voltmeters—RF Signal Generators—AF Generators—Analyzers—Battery Eliminators—Tube Checkers—Condenser Checkers—Computer—Color Bar & Dot Generator—Sweep Generator—Impedance Bridge—Power Supplies—Probe Kits—R/C Decade & Substitution Kits.

ham radio: Transmitters—Receivers—Antenna Accessories—Voice Control—Conelrad Alarm—Variable Frequency Oscillator—SSB Adapter—"Q" Multiplier.

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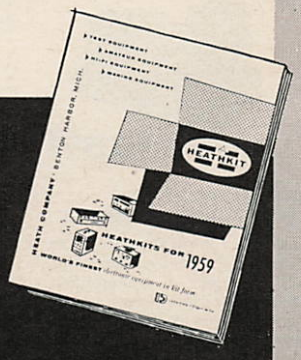

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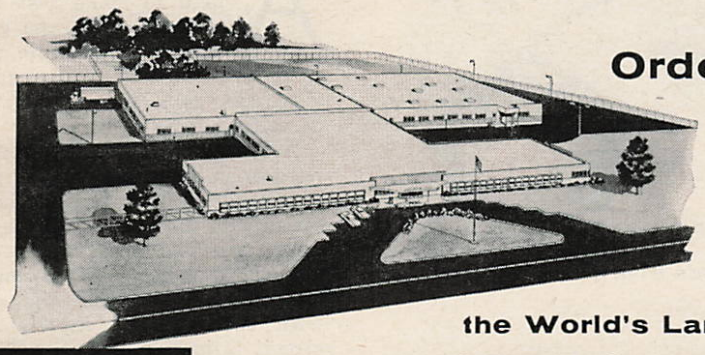

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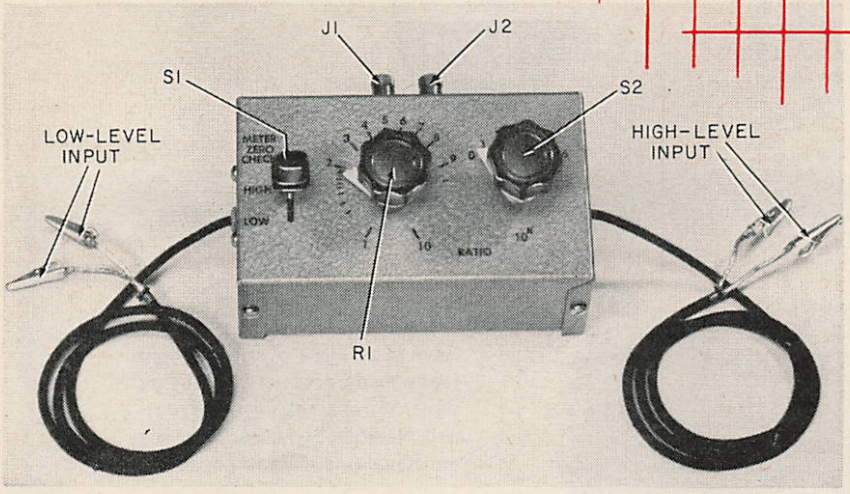
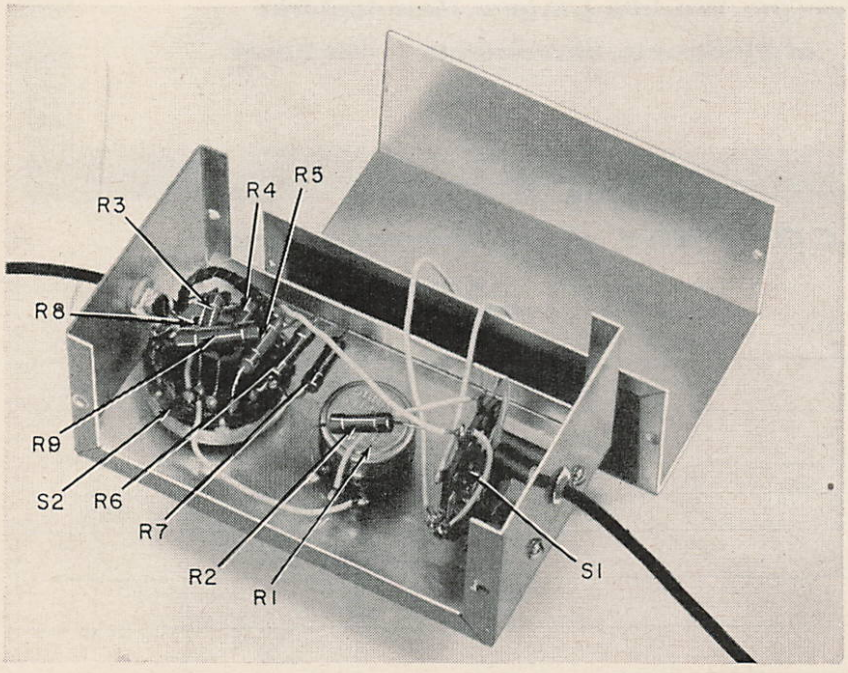


All controls are mounted on comparator's front panel.



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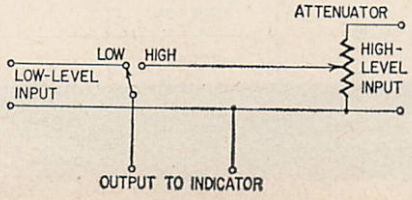

Fig. 1—Basic comparator circuit.

A SIGNAL-LEVEL comparator is used to make fast frequency-response tests and gain measurements on audio amplifiers, to check meter and oscilloscope calibration, and as a general-purpose ac or dc voltage divider.

Although it is very useful, a comparator is extremely simple. It consists of a low-level input that can be switched directly to the output, and a high-level input that is fed through a calibrated attenuator before being connected to the output terminals for comparison with the low-level signal. The basic circuit is in Fig. 1.

When comparing signal levels the amplitude of the low-level signal is first noted on a meter or oscilloscope for a reference. Then the high-level signal is connected to the same indicator and the attenuator is set to reduce it to the same level as the low-level signal. Then, by simply noting the attenuator setting, the ratio of these two signals is obtained.

The attenuator is calibrated in terms of input to output voltage ratio at various settings. For example, with the variable contact set at the top of the attenuator, the input voltage is equal to the output voltage and the ratio is 1 to 1. With the arm at the half resistance point, the input voltage is two times as great as the output voltage. The attenuator can thus be calibrated at various points over its range.

For some uses the comparator can be as simple as the one in Fig. 1. However, for many uses a wider range of attenuation is needed. Fig. 2 is the complete circuit of such a unit. It includes a step attenuator that works in 10-to-1 steps from 1 to 1 up to 10^6 to 1 and a potentiometer to give ratios from 1 to 1 to 10 to 1. This combination provides variable attenuation from 1 to 1 up to 10^7 to 1. The higher ratios are not needed for most purposes and the last two can be eliminated if you wish. They were included in this model to permit direct connection to higher voltage cir-

TEST INSTRUMENTS

R1—pot, 10,000 ohms, 2 watts, counterclockwise log taper (Ohmite CB1031 or equivalent)
R2—1,100 ohms
R3—91,000 ohms, 2 watts
R4—110,000 ohms
R5—1,000 ohms
R6—91 ohms
R7—9.1 ohms
R8—910,000 ohms, 2 watts
R9—9.1 megohms, 1 watt
All fixed resistors ½-watt 1% unless noted
J1, 2—binding posts
S1—1-pole 3-position lever switch (Centralab 1475 or equivalent)
S2—1-deck 2-pole 9-position rotary switch (Mallory 3229J or equivalent)
Case, 5¼ x 3 x 2⅛ inches
Alligator clips (4)
Microphone cable or RG-58/U (5 feet)
Miscellaneous hardware

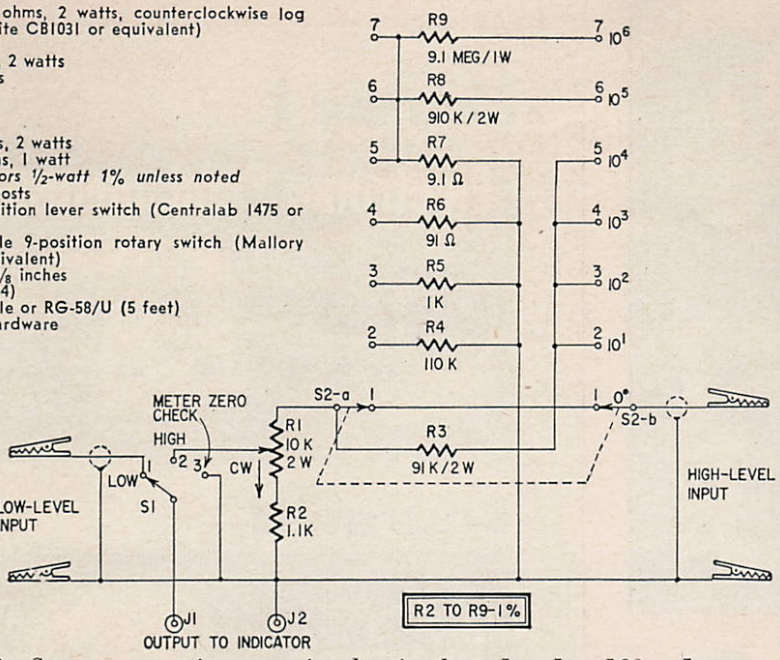

Fig. 2—Seven-range unit covers signal ratios from 1 to 1 to 10^6 to 1.

cuits without exceeding dissipation limits of the resistors as well as to obtain the higher ratios.

For some purposes it may be handier to design the comparator for less than a decade variation over the range of the potentiometer—especially good for measuring small changes accurately. To do this determine the ratio (N to 1) needed and make $R2 = R1/(N - 1)$. R1 is selected to have a low resistance compared with the reactance of the indicator input capacitance at the highest frequency used so the comparator will have a flat response over the desired range. For example, using the values shown in Fig. 2 and an oscilloscope with a 50-$\mu\mu$f input capacitance for an indicator, the capacitive reactance is equal to R1 + R2 at approximately 300 kc. Actual tests show no measurable drop in response up to 100 kc, which is more than adequate for all normal audio work.

If you change the variable attenuator's range, modify the step attenuator so it changes by the same ratio (N to 1) to avoid overlap or gaps in the coverage.

If you want to measure only small variations in the high level (as when making frequency response runs), the comparator can be simplified by using the circuit shown in Fig. 3. The LEVEL ADJUST control is set to reduce the high-level signal to equal the low-level signal with the calibrated attenuator at the 1-to-1 ratio. Level variations at different frequencies are then measured by adjusting the calibrated attenuator for equal signal levels at each frequency and noting its settings.

Construction steps

The comparator is built into a small aluminum box. The parts layout was selected to make the controls easy to use, but there is plenty of room for variations.

There is nothing critical about the wiring. Simply keep the leads short and away from each other and the chassis. Switch S1 is held from the case by two 1-inch metal sleeves. All grounds are connected to the case via a solder lug under one of the mounting screws.

The potentiometer is a good quality 2-watt type with a counterclockwise log taper. This provides a more even distribution of calibration points than would any other taper, and the 2-watt dissipation permits direct connection to 150 volts on the lowest range. On all other ranges except the last two the maximum input voltage is limited by R3's dissipation factor. On ranges 6 and 7, the cable and switch S2 are the limiting components.

The maximum permissible voltages for the various ranges are listed in Table I. For convenience this table can be cemented to the instrument's side.

Many of the less expensive potentiometers do not have a true logarithmic taper, but combine two or more linear tapers to provide an approximation. Such controls give satisfactory results but not as good a spread of calibration points as the one recommended.

Switch (S2) is a two-pole nine-position type that has been stopped down to seven positions. The two extra positions on the S2-b section are used as tie points for the grounded ends of R4, R5, R6, R7 and the shield of the high-level input cable.

All fixed resistors are 1% tolerance types. If you have an accurate bridge, you can use selected 5% units. When soldering them, hold their leads with long-nose pliers to prevent damage due to overheating.

Calibrate before using

If a resistance bridge is available, use

(*Continued on page 80*)

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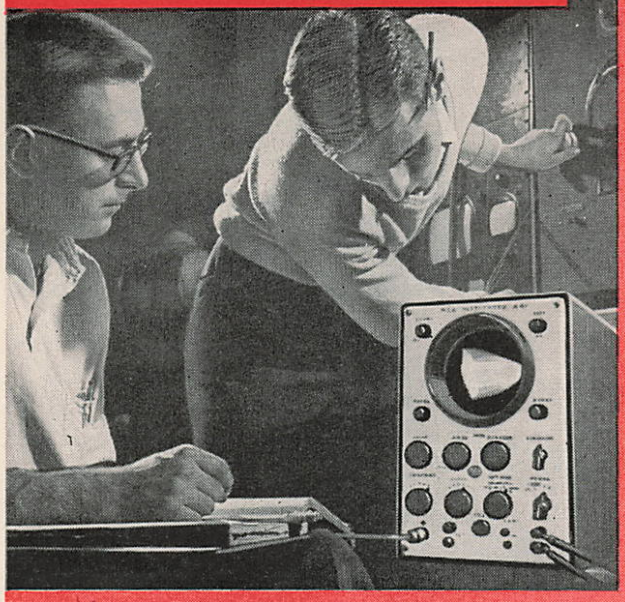

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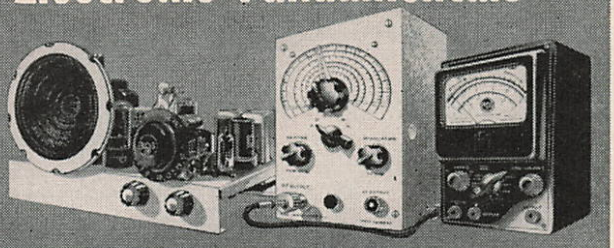

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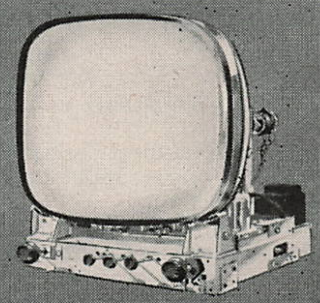

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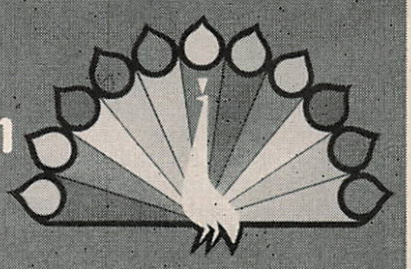

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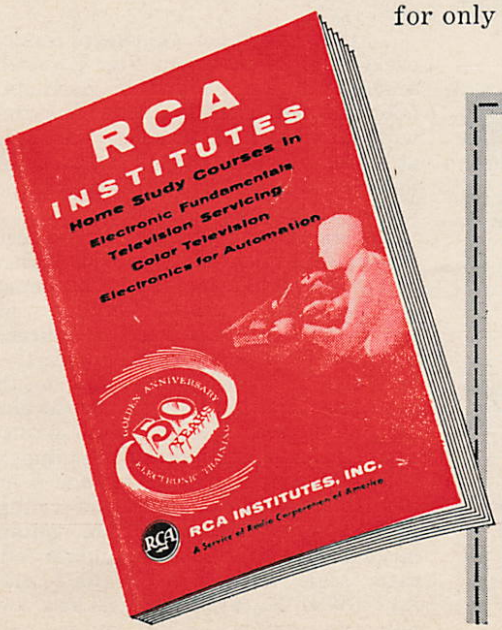

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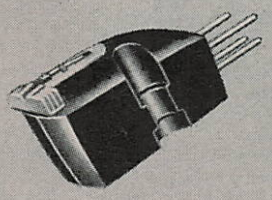

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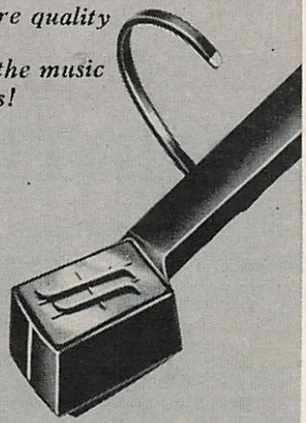

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TEST INSTRUMENTS

(*Continued from page 77*)

it to calibrate the unit. Otherwise, a high-impedance voltmeter will do. A meter's dc calibration is usually more accurate than the ac calibration, so use dc when calibrating the comparator with a meter.

To use a resistance bridge, connect it to the comparator's output terminals, set switch S1 to HIGH, S2 to 1, and R1 completely counterclockwise. Make a calibration line at this point and label it 1 with decals or India ink. Now measure the resistance with R1 at this point and then rotate the control completely clockwise to measure R2's resistance. If satisfactory, label this point 10 and return R1 to the counterclockwise position. Now adjust R1 to present the various resistance levels listed in Table II. The resistance being measured is R2 plus enough of R1 to give the value listed. Label all of the points needed, and calibration is completed.

If a voltmeter is used for calibrating, connect it to the output terminals and a convenient voltage to the high-level input terminals. Set the controls as before with R1 in the counterclockwise position. Note the voltmeter reading and then rotate R1 clockwise to give voltmeter readings to equal: original reading/1.1, o.r./1.2, o.r./1.3, etc. until all desired calibration points are determined.

The calibration of my model is in terms of voltage ratio but for some uses db may be better. Either way, keep in

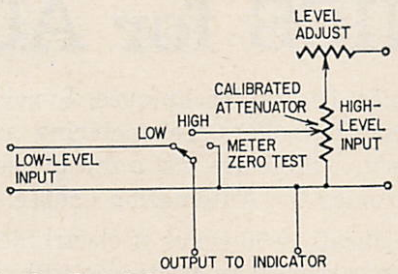


Fig. 3—Simplified circuit for measuring only small variations in high-level signals.

TABLE I

S2 Position	Attenuation Ratio	Maximum High-Level Input (volts)
1	1:1	150
2	10:1	420
3	100:1	420
4	1,000:1	420
5	10,000:1	420
6	100,000:1	1,000
7	1,000,000:1	1,000

TABLE II

R1 Dial Reading	Resistance at Output Terminals (ohms)	R1 Dial Reading	Resistance at Output Terminals (ohms)
1	11,100	2	5,550
1.1	10,100	3	3,700
1.2	9,250	4	2,775
1.3	8,540	5	2,220
1.4	7,930	6	1,850
1.5	7,400	7	1,586
1.6	6,940	8	1,388
1.7	6,530	9	1,233
1.8	6,170	9.5	1,168
1.9	5,840	10	1,100

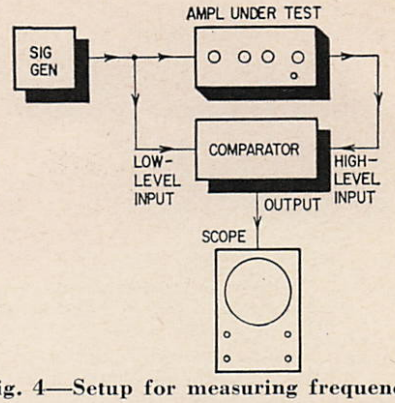


Fig. 4—Setup for measuring frequency response.

mind that the final accuracy can be no better than the calibration.

How to use it

To make frequency response measurements connect the signal generator, amplifier, comparator and indicator as in Fig. 4. Try reversing each ac power-line plug to keep ac ripple on the indicator at a minimum.

Starting at one end of the frequency range, where the amplifier's response is minimum, adjust the generator to produce a suitable output from the amplifier—without overdriving the amplifier. Throw S1 to LOW and note the signal level. Now throw S1 to HIGH, set R1 to 1 and S2 to give a signal near the level of the LOW signal. Then adjust the amplifier gain control to make the HIGH output exactly equal to LOW output. Now move on to the next frequency, note the level of the LOW signal and adjust R1 until the HIGH signal again equals the LOW signal. The attenuator setting now indicates the signal level at the new frequency as compared with the original frequency. Now go on to the next frequency, checking it and all other necessary frequencies in the same way.

If you use a vtvm as the indicator, its zero adjustment can be checked periodically by throwing S1 to METER ZERO TEST.

To make amplifier gain tests connect everything as shown in Fig. 4, set the amplifier's gain control at maximum, note the signal level at LOW and then with the attenuators reduce the signal at HIGH to equal that at LOW. The attenuator settings now show the amplifier's voltage gain.

Meters and oscilloscopes can be accurately calibrated over a wide range, using the comparator. To do so, connect an accurately known voltage, big enough to use on the highest indicator scale, to the HIGH input terminals. Connect the meter or oscilloscope to the output terminals. Then set the attenuator to various points in the desired range and note the indicator readings.

If a suitable high-level voltage is not available, connect a known low voltage to the LOW input and a variable voltage large enough to use on the highest indicator scale, to the comparator's HIGH input. With R1 set at 1 and S2 at a suitable point, adjust the high voltage until

the HIGH and LOW outputs are equal. Now the high voltage is of known level, since the low voltage and attenuator ratio are known, and can be used as the calibration standard.

To illustrate this with a practical example, the low-voltage source can be a 1.34-volt mercury cell. Connect it to the LOW input terminals. Connect a variable 0–150-volt dc supply to the HIGH terminals. Set R1 to 1 and S2 to 10^2. Throw S1 to the LOW position and read the meter. It should be 1.34. Throw S1 to HIGH and adjust the variable voltage until the meter reads the same as in the LOW position. Now the variable voltage will be 100 times greater than the mercury cell or 134 volts. By adjusting R1 and S2, any voltage between 1.34 and 134 can be obtained at the comparator's output terminals.

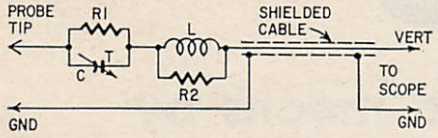
By connecting any high-voltage source to the HIGH input terminals and taking the output from the output terminals the comparator can be used as a general-purpose voltage divider. However, be sure you don't exceed the voltage limits in Table I unless higher-wattage resistors are used. END

LOW-CAPACITANCE PROBE

By ROBERT G. MIDDLETON

We usually think of a low-capacitance probe as a device to step up a scope's input impedance. By adding a damped peaking coil to the probe circuit, you also improve the scope's high-frequency response, important when checking video circuitry.

R1 and C are the usual components used in a low-capacitance probe. Peaking coil L and damping resistor R2 are added. The required value for L is between 150 and 250 μh. The best value for this inductor must be determined



by experiment. R2, about 10,000 ohms, is not critical.

This probe gives the greatest advantage on old-model scopes which do not have peaking coils in the vertical amplifier. To select L and to adjust the probe for best response, apply the output of a video sweep generator to the probe's input. Then view the probe's frequency response curve on the oscilloscope screen.

Try different values for L, and each time it is changed adjust C for the flattest possible frequency response. Use as small a value for L as possible, consistent with a flat response. Correct probe adjustment will give two to three times greater bandwidth than was previously available in old-model scopes.

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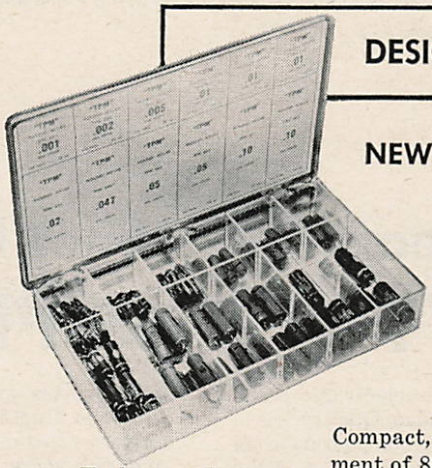

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At Philco it has been quality first in electronic products for *over 30 years!* "Guard Philco Quality" is a watchword and a creed! The first consideration in every phase of production is the maintenance of the highest standards of quality. In all plants an independent team of Product Performance Specialists is directly responsible to Philco management for the performance and dependability of all Philco products.

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The proven and outstanding dependability of all Philco products is acclaimed by the millions of satisfied customers who have bought and used Philco products over the years. Philco goes to the greatest lengths to build in durability and quality that guarantee superior performance, dependable operation and long life in the consumer's home. It is this built-in dependability that pays off in satisfied customers for you.

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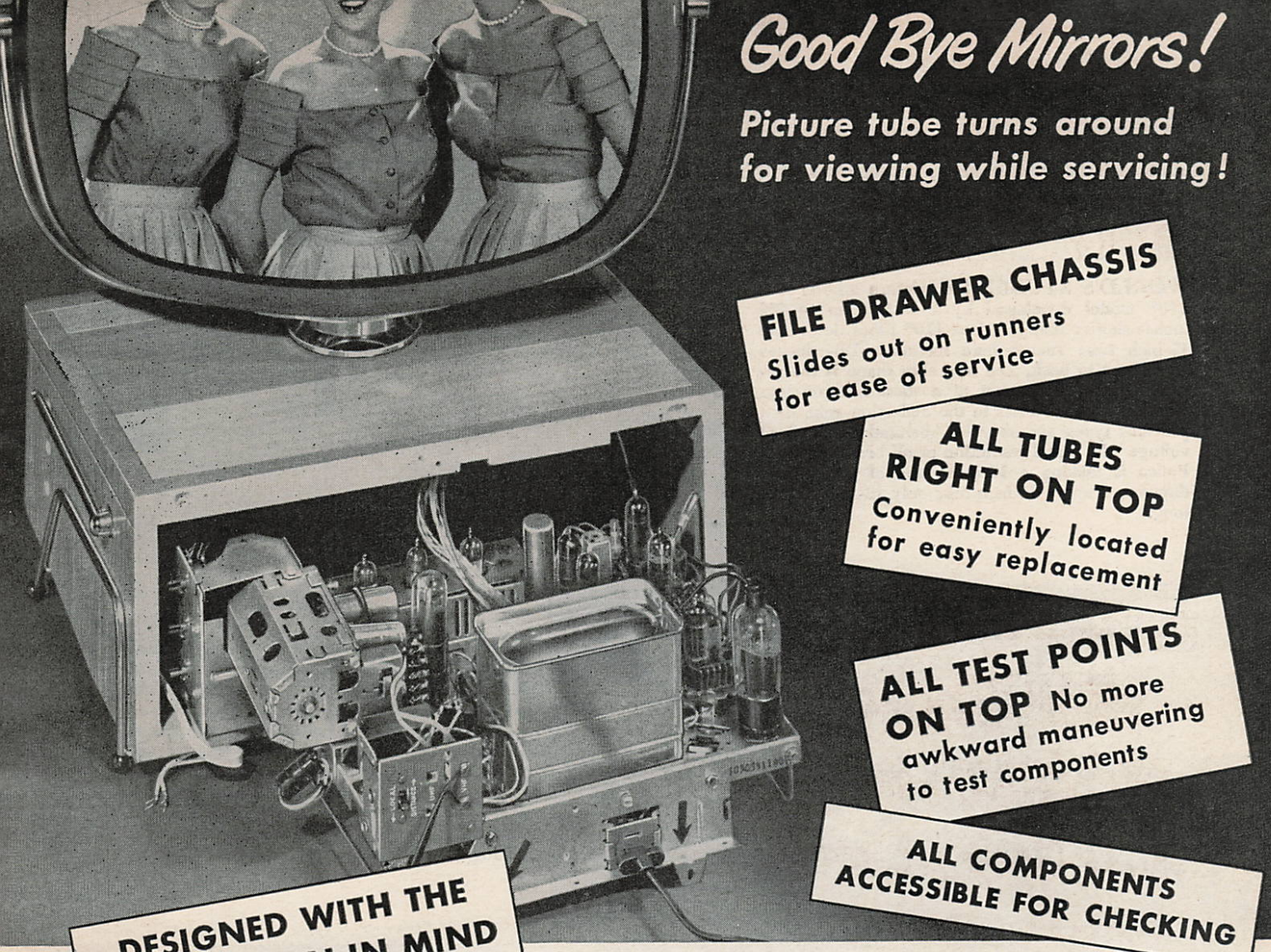

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Picture tube turns around for viewing while servicing!

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ALL TUBES RIGHT ON TOP
Conveniently located for easy replacement

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The new Philco Predicta chassis pictured above was designed with the service man in mind. It was designed to enable you to take the greatest advantage of your professional skills. It was designed to pay off by enabling you to do your job quicker . . . make more calls and, thus, increase your profits. All Philco chassis are manufactured with the most modern automated methods in the industry insuring uniformity and dependability in your customers' homes.

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Cover Feature in December "Radio-Electronics"

Here is what they say about Philco Predicta TV.

"*In the story of design for '59, it can hardly be disputed that one of the most unusual and extraordinary is that of the Philco Predicta line which includes the slide-out 'easy service' chassis and its separately and remotely mounted picture tubes.*"

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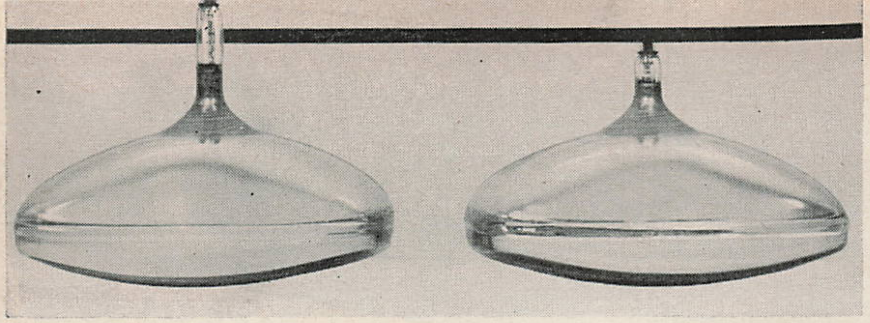
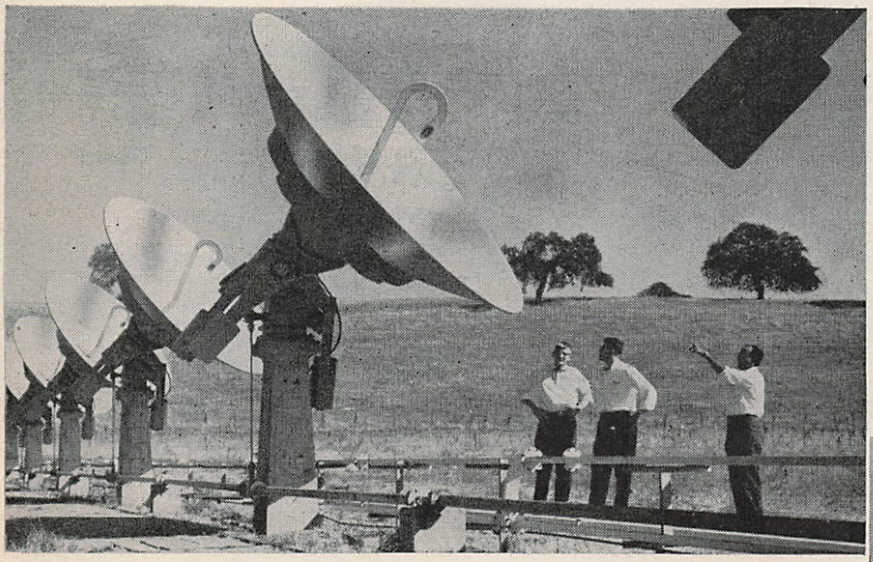
QUALITY *the World Over*

what's new?



WORLD'S STUBBIEST picture tube is new 110° model developed by Sylvania, up to 2⅛ inches shorter than previous 110° tubes (left). The 17-inch tube shown here measures 10¼ inches from front to back. The new slim shape is the result of the development of a short electron gun which is located closer to the deflection yoke than previous types and may be operated at standard voltage with equal resolution at all beam currents. Philco is making a 17-inch tube of comparable dimensions and a 21-inch tube only 12-1/16 inches long.



SUN'S RADIO WAVES are being studied with this new type radio telescope at Stanford University, Palo Alto, Calif., although it is only half completed. Its resolution will equal that of a single 365-foot dish antenna. At present it consists of 16 aluminum parabolic reflector antennas, each 10 feet in diameter and interconnected electronically and mechanically to move in unison, scanning the sun all day. Later a matching row will bisect the present one, making a huge cross of 32 dishes.

PERSONAL PORTABLE TV, a developmental lab model demonstrated by General Electric, uses 22 transistors and an 8-inch picture tube. Weighing 10 pounds and about the size of a toaster, it will operate 3-4 hours on a rechargeable silver-cadmium battery and may be operated on house current while the battery is being recharged. Power consumption is 7½ watts. There is no immediate prospect of the set being made commercially. A spokesman for G-E's TV Receiver Dept. points out that present transistor prices prohibits marketing it at an acceptable consumer price.

RADAR ANTENNA for Signal Corp's new "3-D" Frescanar (frequency scanning radar) system is shown in a plastic bubble with two of its developers, Hughes Aircraft engineers E. W. Templin and Dr. Nicholas A. Begovich. Designed for missile monitoring, Frescanar uses single antenna to detect distance, bearing and altitude, requires but one operator and has greater range, speed and resolution than conventional radar.

PORTABLE Test Instruments

Over a couple of cups of coffee, Red and Fuzzball discuss types of equipment used in outside color TV servicing

By ROBERT G. MIDDLETON
TELEVISION CONSULTANT

THERE was a real gentleman come in about an hour ago," Bess advised Fuzzball.

"There ain't no gentlemen around here," Fuzz replied skeptically.

"This old goat was," Bess maintained. "Left me a dollar tip."

"I notice you been making some corny remarks lately," Fuzzball warned her. "You better be good or I'll turn you over my knee and give you a spanking."

"I'd like to see you try," Bess replied bridling.

"Tell me, Fuzz," Red interrupted, "how are you making out with your new Philco hootnanny?"

"Oh, you mean the switch box for the base of the picture tube." (See Fig. 1.)

"Aiyuh."

"I'm making out," Fuzzball replied. "There's only one angle I can't figure."

"So?"

"Them two binding posts on the box," explained Fuzzball. "What are you supposed to do with them?"

"Come back, come back, Fuzz," Red replied, snapping his fingers. "I told you about them last time. Remember?"

"I must of forgot somehow," Fuzzball admitted.

"I'll tell you once more," Red advised him, "and try to remember this time."

"OK, OK," Fuzzball agreed humbly.

"Like I said before," Red continued, "you connect a scope to those posts."

"Now it rings a bell," Fuzz recalled. "You can switch the scope to the red, blue or green grid, or to the cathodes of the picture tube."

"And . . ." Red encouraged him.

"Well, of course we know that you can switch on the red, green or blue fields by themselves. Or all three together," Fuzzball added.

"Do you reckon you can mind what we just said?" Red asked.

"I'll remember to my dying day," Fuzz promised.

"When he gets off on that kick, I pass," Bess announced, walking out of the room.

"I'll also remember about the trigger cheater for the high voltage on the Sylvania," Fuzzball offered.

"That's mighty big of you," Red replied.

"But just one thing . . ." Fuzzball hesitated.

"Like what?"

"If there ain't no tubular cheater, how am I going to measure the high voltage on the Sylvania?"

"Look," said Red, pulling a tear sheet from his pocket. "You take off the high-voltage cage. Stick the probe here at the corona cup on the high-voltage rectifier tube." (See Fig. 2.)

"I rang the bell the second time," Fuzzball said ruefully. "I recollect now you told me that last time."

"Is that something I ain't supposed to know?" Red asked good-naturedly.

"How about the fuses?" Fuzzball asked. "Where would I find them on the Sylvania?"

"Right down by the selenium rectifiers," Red explained, "look here." (See Fig. 3.)

"I dig you," Fuzz replied. "Even the size of the fuse is marked."

"Sure saves aggravation when you got to put in a new one," Red replied.

"One thing I sure go for on the Sylvania," Fuzzball announced.

"What's that?"

"That convergence box on the extension cables," Fuzz explained. (See Fig. 4.) "I can stand right in front of the screen while I'm going through convergence."

"I stand corrected," Red grinned. "I figured convergence went through *you*. But you're right. In fact, quite a few of the new color receivers use this kind of a convergence box."

Fuzzball and Red both looked toward the kitchen. A cracked voice was working over "Casey Was Waltzing With the Strawberry Blonde." Bess came out of the kitchen shaking her head.

"Who put the nickel in *him?*" Red asked.

"We got a new shipment of vanilla extract in," Bess explained, "and the cook figured he ought to see if it was up to snuff."

"Tell him to stick to snuff," Fuzzball suggested. "It's less revolting."

"But not much," Bess pointed out.

"You know what?" Fuzzball asked.

"No, what?" Red returned.

"I'm doing the convergence with the dots separated."

"Some guys figure it's easier that way," Red agreed.

"Seems a little easier," Fuzzball observed. "When I get the dot separations all the same, then they slide in easy with beam magnets." (See Fig. 5.)

"Same thing with crosshatch," Red added. "Lots of guys like to keep the color lines about ⅛ inch apart. Then when they get even ⅛-inch spacings all over the screen, all they got to do is turn the beam magnets and the entire

(*Continued on page* 90)

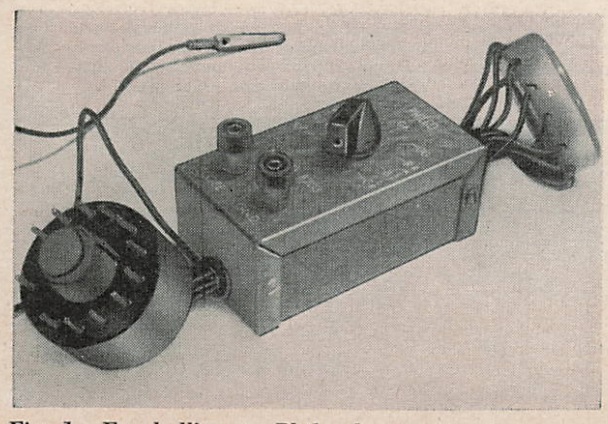


Fig. 1—Fuzzball's new Philco hootnanny.

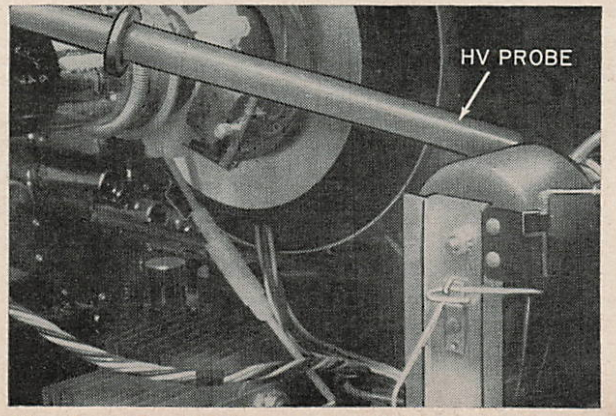
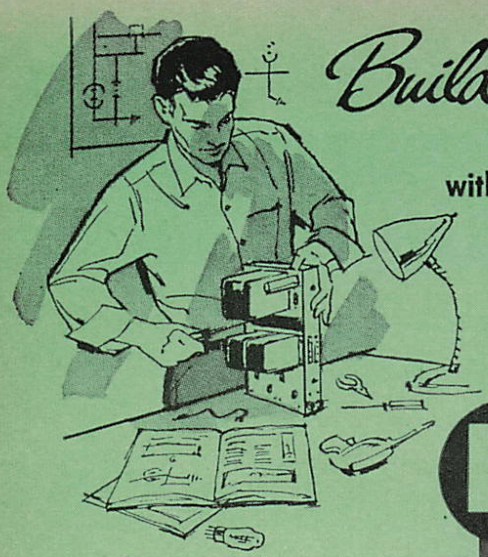


Fig. 2—Red told Fuzz to take off high-voltage cage.



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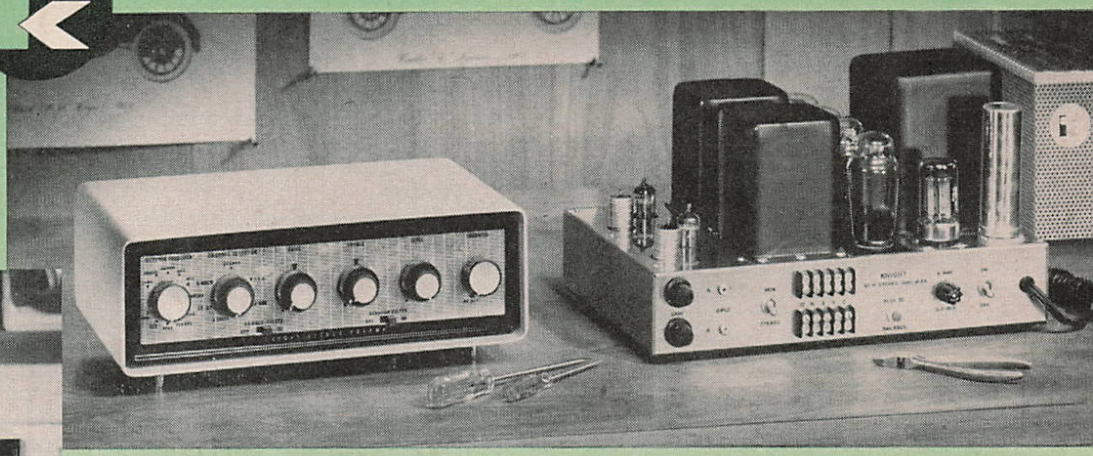

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Absolutely the finest dual amplifier you can build—equal to highest-priced factory-built units. Ideal for use with the KNIGHT-KIT preamp, either as two 30-watt stereo amplifiers or 60-watt monaural amplifier. Exceptional response from 10 cps to 42,000 cps. Phenomenal 0.08% distortion at full 60 watts. Includes static plate current balancing adjustments for each channel; absolute stability under all operating conditions; custom-quality transformers. Also has special built-in circuitry, with easy external adjustment, for precise balance of gain on each channel to achieve perfect monaural performance. Two printed-circuit boards for easy assembly. Beautiful black and chrome; 9 x 14 x 8¼". (Less cover.) 36 lbs.

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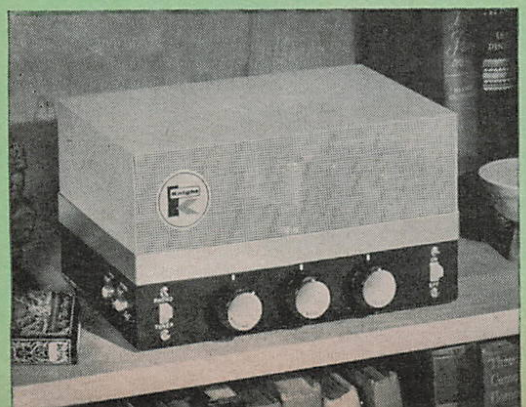

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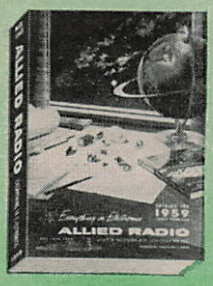

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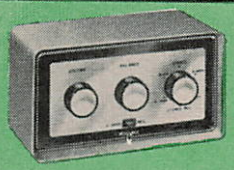

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Provides full centralized stereo control (volume, balance and channel selection) for use with **any** two amplifiers. Handles up to 20 watts program material. Unit simply connects between speakers and output terminals of amplifiers (no amplifier rewiring needed). Lets you balance speaker system volume; provides master gain control for overall volume (can be used remotely); lets you play either channel monaurally through one or both speakers; provides channel reversal; phase reversal switch for best overall performance. 4½ x 7¾ x 4". 3½ lbs.

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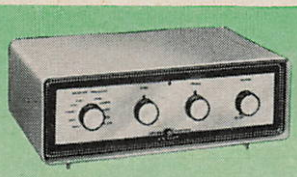

18-Watt Hi-Fi Amplifier Kit

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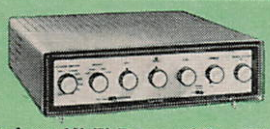
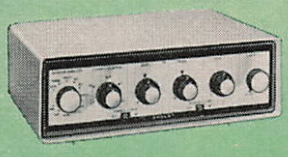
Model Y-797. Net only **$39.95**



Deluxe Hi-Fi Preamplifier Kit

Quality audio control center. 16 combinations of equalization; 8 inputs including tape head; DC on all tube filaments; printed-circuit switches and boards. Custom-styled. 12½ lbs.

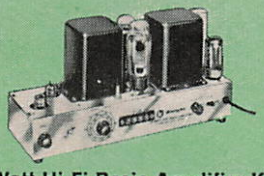
Model Y-754. Net only **$39.95**



30-Watt Hi-Fi Amplifier Kit

Linear-deluxe Williamson-type circuit. Clear, rich 30 watts output; full equalization; 8 inputs; level and loudness controls; DC on filaments of preamp tubes; rumble filter; variable damping. Exclusive printed-circuit switches and boards. Custom-styled. 32 lbs.

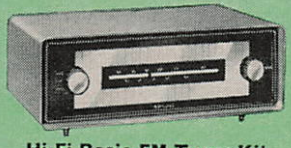
Model Y-762. Net only **$76.95**



25-Watt Hi-Fi Basic Amplifier Kit

Williamson-type circuit. Response, ±0.5 db, 9-70,000 cps at half power. Includes balance control; calibrated damping control; potted output transformer. Shpg. wt., 25 lbs.

Model Y-793. Net only **$44.50**



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Authentic Hi-Fi FM response. Includes AFC; flywheel tuning; pre-aligned RF and IF coils. 4 microvolt sensitivity guaranteed. Printed-circuit board for easy assembly. Custom-styled case. Shpg. wt., 12 lbs.

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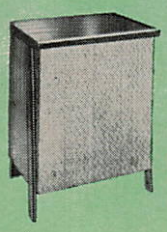

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Pre-finished enclosure; easy to assemble. Hi-fi response, 45-14,000 cps. Includes 12" woofer and horn-type tweeter. Available in mahogany, blonde or walnut (specify finish). 26 x 29 x 14". Shpg. wt., 33 lbs.

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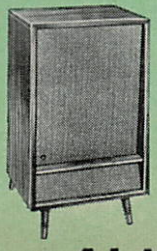

Deluxe "Ducted Port" 3-Way Speaker System Kit

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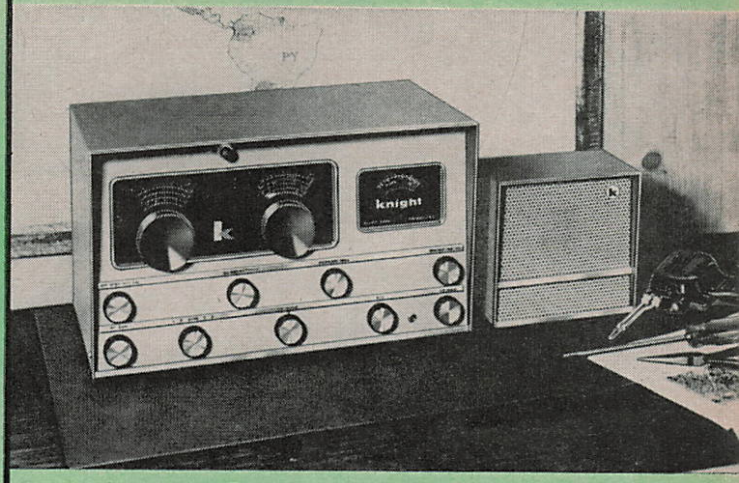

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Has all the selectivity, sensitivity and features of high-priced commercial units. Covers 540 kc to 31 mc in 4 ranges; calibrated, electrical bandspread on 80-10 meter Ham bands; slug-tuned Hi-Q coils; continuous, VR tube-regulated B+ applied to HF oscillator; built-in Q-multiplier; delayed AVC; provision for Y-256 crystal calibrator (below). Sensitivity, 1.5 microvolts for 10 db signal-to-noise ratio. Selectivity: variable from 300 cps to 4.5 kc at 6 db down. Exalted BFO injection for SSB. Controls: Main tuning, bandspread, band selector, BFO pitch, RF gain, AF gain, BFO-MVC-AVC-ANL, off-stby-rec-cal, ant. trim.—plus Q mult. controls: null-off-peak, selectivity, tune. Phone jack on front panel. Exclusive printed-circuit bandswitch; printed-circuit boards. Handsome metal cabinet, 10 x 10 x 16½". (Less speaker and S-meter.) 23 lbs. **$104.50**

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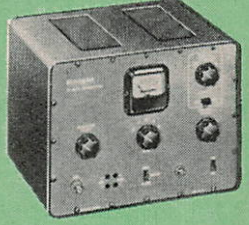

50-Watt CW Transmitter Kit

Ideal for the novice. Convenient bandswitching, 80 through 10 meters. Efficient pi-network antenna coupler; effective TVI suppression. Uses 807 in final. Shpg. wt. 18 lbs.

Model Y-255. Net only **$38.95**

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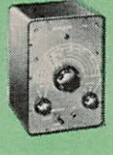

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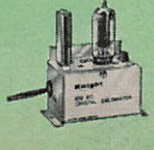

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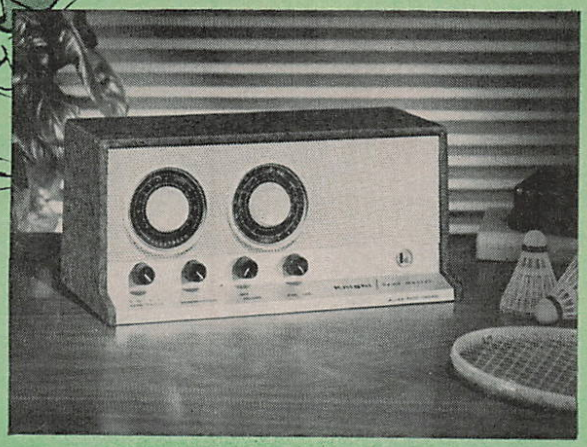

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Imagine the thrill of hearing overseas broadcasts on a precision receiver you've built yourself! At the flip of the bandswitch, you tune in the world—continuous 4-band coverage from Broadcast to 30 mc—fascinating foreign broadcasts, ships-at-sea, aircraft, police and marine radio, amateur reception on 80, 40, 20, 15 and 10 meters—all this wonderful short-wave, **plus** enjoyable local broadcast reception. Features sensitive regenerative circuit; easy bandspread tuning; built-in 4" Alnico V speaker; headphone terminals; speaker cutout switch. Controls: Main Tuning, Bandspread, Bandswitch, Volume, Coarse and Fine Regeneration. Easy to build from marvelous instruction manual. Handsome cabinet; 6¾ x 13¾ x 6¼". For 110-125 v. AC. Shpg. wt., 7 lbs.

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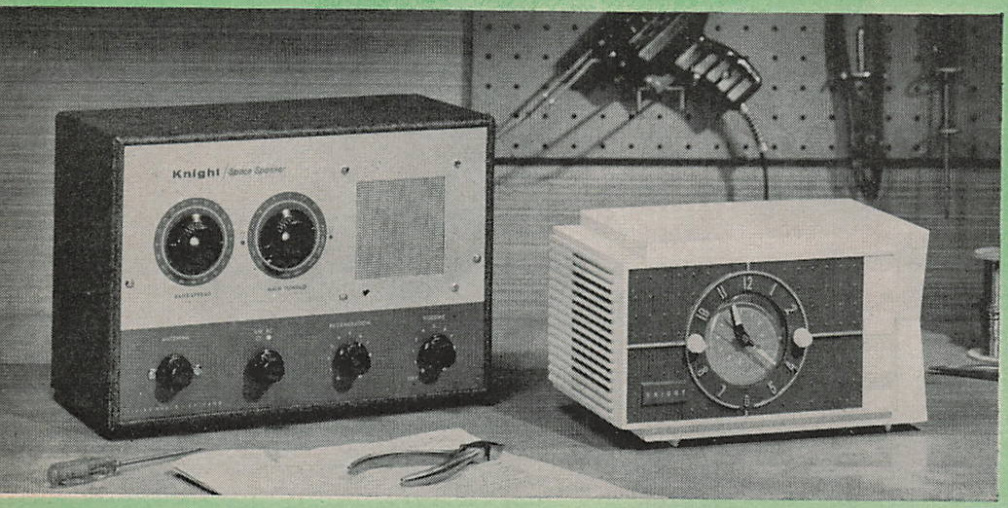

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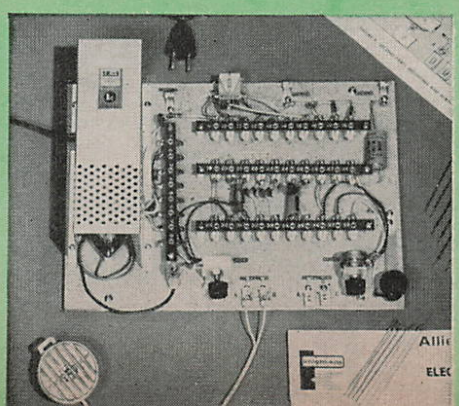
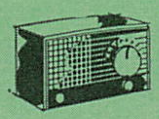


"Ranger III" AC-DC Radio Kit



Superhet broadcast band receiver. Built-in antenna; AVC; Alnico V speaker. Black plastic cabinet. AC or DC. Shpg. wt., 4½ lbs.

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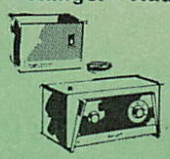

It's a broadcast band radio—it's an efficient 2-way intercom—both in one! Ivory plastic case for Master station/Radio; smartly styled Remote station. With 50-ft. cable. AC or DC. Shpg. wt., 8 lbs.

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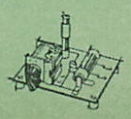

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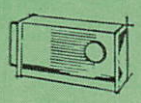

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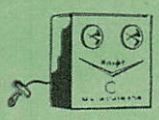

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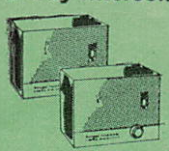
2-Way Intercom System Kit



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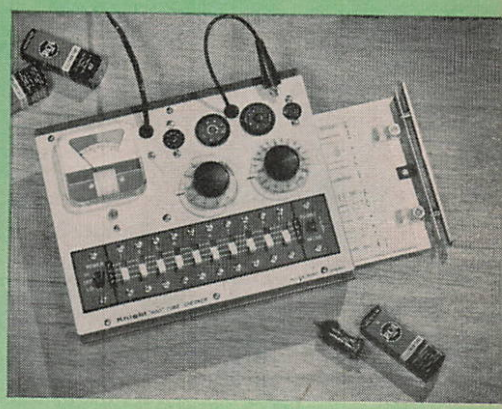

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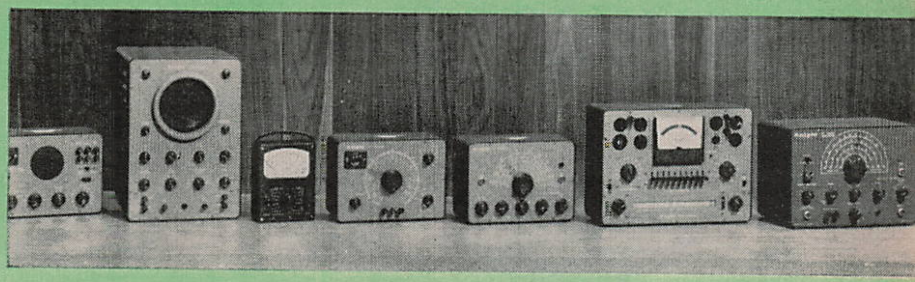

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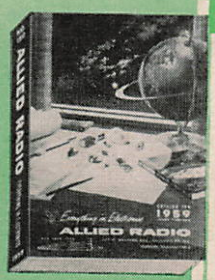

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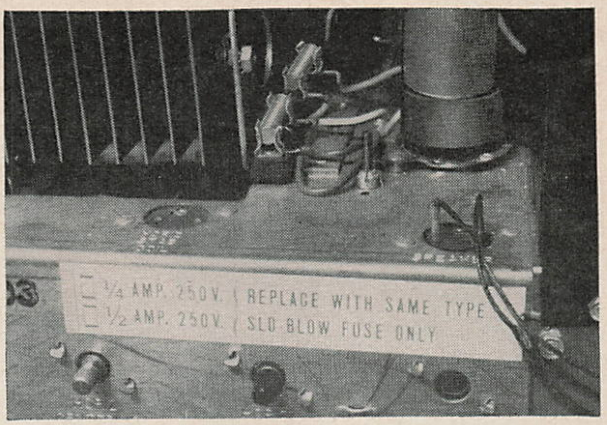


Fig. 3—Fuzzball digs the fuses on the Sylvania.

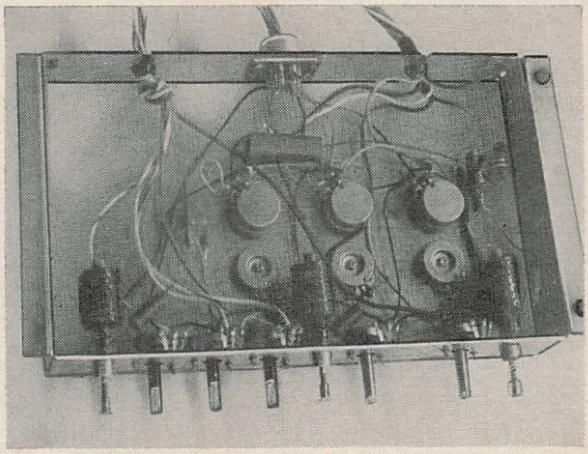


Fig. 4—Portable convergence boxes—Fuzz likes 'em.

(*Continued from page* 85)

screen comes into convergence."

"And another thing . . ." Fuzzball ventured.

"What's eating you now?"

Three kinds of generators

"These color signal generators we're using. We got three kinds now, and I'm foxed up worse than Hogan's goat."

"We do have different kinds," Red agreed, "and for different reasons."

"I dig the rainbow the most," Fuzz told him. "I been taking that little rainbow along on all my calls."

"A rainbow, if it's crystal-controlled, is it for installation work," Red explained. "It's light, compact, and accurate. And it gives you all the data you need to install a set."

"Just what is the difference between a rainbow and an NTSC generator?" Fuzz asked with a puzzled look.

"Well," Red explained, "the NTSC system of color TV transmits true colors that vary in accordance with the program material."

"Is that what NTSC means?"

"Not exactly," Red replied patiently. "In the NTSC system, the color picture is broken into two parts."

"Two parts?"

"One plus one equals two," Red emphasized. "The color picture is broken up into the black-and-white portion and the color portion."

"That would be the Y signal and the chroma signal," Fuzzball ventured.

"You're cooking with gas, boy," Red complimented him. "The Y signal is just the same video signal that we have known for years in black-and-white."

"And the chroma signal," Fuzzball continued uncertainly, "is the 3.58-mc color subcarrier?"

"Right," Red replied. "Do you know what the basic properties of color are?"

"Seems I recall that all colors have brightness, hue and saturation," Fuzzball said slowly.

"You recall right," Red assured him. "And what is the Y signal?"

"That's the brightness signal—I know that much, anyhow," Fuzzball said proudly.

"Yep. And so the chroma signal is the hue and saturation signal."

"Then an NTSC color bar generator has both a Y signal and a chroma signal?" Fuzzball asked.

"Exactly," Red replied. "And a rainbow generator . . ."

"I reckon it has the chroma signal but no Y signal."

"You're right on the beam," Red said with a grin. "Let's have another cup of Bess' dishwater."

"I heard that last remark," Bess said. "A little more of your lip and I'll crown you king for a day," she promised, raising a pot of hot soup to emphasize her words.

"These little things are sent to try us," Red replied soothingly.

"This color TV work is the curse of man," Fuzzball said reflectively.

"Work is the curse of the drinking class. Any kind of work," Red assured him. "Shake a leg there, Bessie."

"To go a little farther into the difference," Fuzzball suggested, "you could say that a rainbow generator is

an incomplete NTSC generator."

"Yes and no," Red pointed out. "A rainbow generator does not operate at the color subcarrier frequency, but on an offset subcarrier frequency."

"This halfway rings a bell," Fuzzball said. "A rainbow generator runs at the subcarrier frequency minus the horizontal scanning frequency, I heard somewhere."

"Right you are," Red corroborated, "and if you want to get technical about it, a rainbow is a color simulator—period."

"But it works out OK for us on installation," Fuzzball observed.

"You ain't just a-woofin'," Red replied. "It's a real good deal for field work."

"How about bench work?"

"That depends on whether the rainbow output is keyed, for one thing," Red informed him. "An unkeyed output has very definite limitations."

"But suppose the rainbow is keyed up into bars?"

"In that case, you can get by on bench work, if you use your head."

"What are you driving at?"

"Well, No. 1, you have no white bar on a simulator."

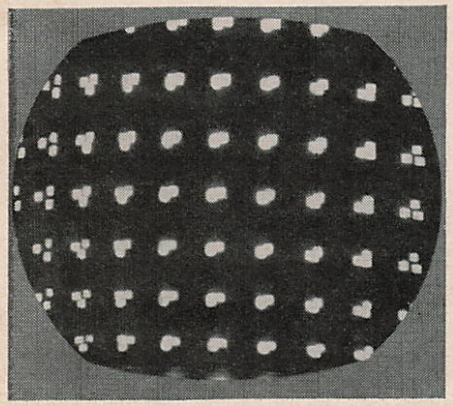
"What do you do about that?" Fuzzball asked.

"You have to check white reproduction on a station signal," Red explained.

"What else?"

"You can't check reproduction of light colors such as yellow," Red continued.

"But you could get a pretty good check on darker colors like green and red, that make yellow when they're



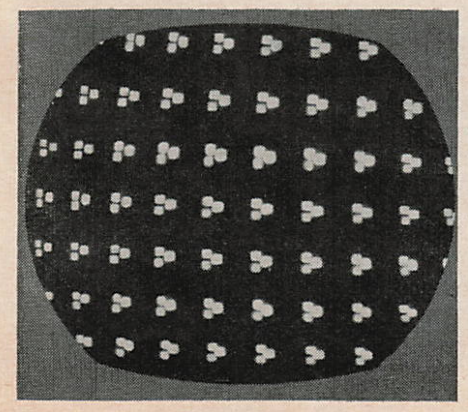


Fig. 5—(top) Misconverged white dots; (bottom) dots ready to be converged with beam magnets.

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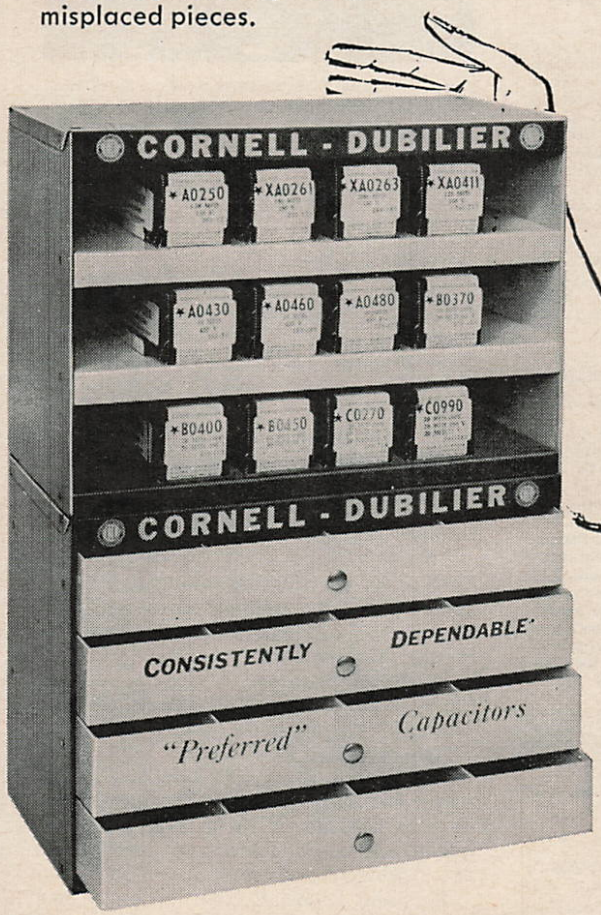

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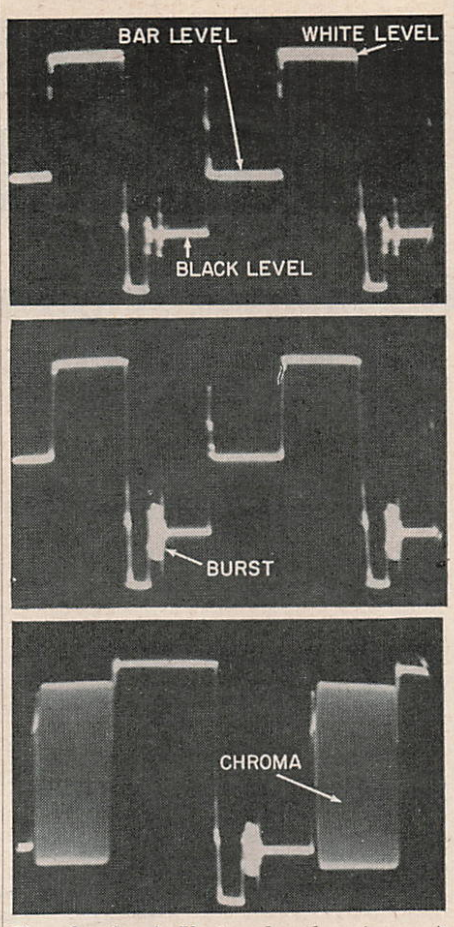


Fig. 6—(top) Y signal only; (center) Y signal with burst; (bottom) Y signal with chroma bar and burst.

mixed," Fuzzball suggested.

"You're really using your bean," Red acknowledged. "What you say is absolutely right."

"What else?"

"This is something you wouldn't get to for a while," Red explained, "but there are certain kinds of trouble in a color chassis where the Y signal gets into the chroma section and causes trouble."

"So if a generator doesn't have a Y signal, you could beat the devil around the stump quite a while."

"Yep. There is one point here, though, that you should keep in mind."

"Namely?"

"A few of the higher-priced simulators have the rainbow on a pedestal. That way, you can make the basic Y checks, at any rate."

Bess interrupted. "Say, you guys know so much about electricity, maybe you can tell me something."

"Shoot," Red invited.

"I'm fixing to hit the sack last night after the snowstorm," she explained. "I jerk off one of these silk stockings quick-like, and a blue spark jumps from the stocking to my toe."

Red and Fuzzball both looked at her quizzically.

"What causes that?" Bess asked.

"You must be wearing shocking stockings," Fuzzball observed.

"Don't talk silly," Bess snapped, "I'm asking you a serious question."

"Science probably knows the answer," Red advised her, "but I couldn't tell you. I never wore silk stockings."

"Maybe you ought to wear a ground wire and let it drag behind you," Fuzzball suggested helpfully.

"What's a ground wire?" Bess asked.

"It's pretty technical," Red informed her. "Let's not go into that. You probably wouldn't like it, anyhow."

How about the color test pattern?

"Say, Red," Fuzzball spoke up, "is the color test pattern the same as the output from an NTSC color bar generator?"

"Always breaking out in fresh places," Red observed. "A test pattern from a color TV station has the same type of signal as an NTSC generator. But there is just one thing."

"What's that?"

"The color test pattern is transmitted at 75% saturation. Most color bar generators supply a signal at 100% or 50% saturation. Up-to-date generators have a switch for going from 100% to 50%."

"But I suppose you could adjust the generator to put out a 75% saturated signal?"

"That's right," Red replied. "With a good wide-band scope, it's no bind."

"Why is a color test pattern 75% saturated?"

"Because that is the highest saturation used in normal programming," Red explained.

"I sometimes wonder if I'll ever know my way around this color TV racket," Fuzzball muttered.

"Don't forget that success is as easy as failure—sometimes easier," Red said firmly.

"Does a color TV station ever transmit 100% saturated colors?" Fuzzball asked.

"Once in a great while, you will have a colored object in a scene that is 100% saturated," Red told him. "But when that happens, the picture carrier is temporarily overmodulated."

"What does that mean?"

"Well, the color is not reproduced quite correctly. It is distorted."

"Then why can we use 100% saturated color bars from a generator?" Fuzzball persisted.

"Simply because in a generator, a little more leeway is allowed between

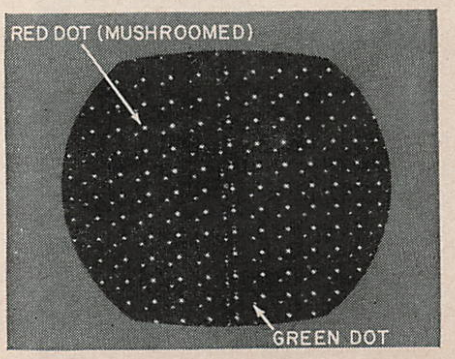


Fig. 7—Red and green dots on screen; red dots mushroomed.

white level and zero carrier."

"Is it good to have the 100% saturated output?"

"Definitely," Red replied, "just as it's good to have a 50% saturated output. Depends upon the test that you are making."

"Can you give me a f'rinstance?" Fuzzball asked.

"I could, but that would get us a little off the beam into bench work," Red observed. "Let's take a raincheck on it there."

"OK by me," Fuzzball replied.

"Say, Red."

"What?"

"Does an NTSC generator give you the Y signal with burst only?"

"Most of them do," Red informed him. "Look at these pictures in my notebook." (See Fig. 6.)

"I see what you mean," Fuzzball agreed. "Why do we have the Y signal and also Y with burst?"

"That gets us into circuit testing again," Red replied. "I doubt if we ought to go into the details now."

"Suits me," Fuzzball agreed. "I'm getting a little punchy as it is."

"Anything else you want to cover before we get on our horse?" Red asked.

"Yes, there is," said Fuzzball. "When you have a white dot pattern on some sets, the red dot seems to spread out more than the blue and green dots. Why is that?"

Red flipped several pages in his notebook. "You mean like this?" he inquired. (See Fig. 7.)

"That's the deal," Fuzzball exclaimed. "What causes it?"

"There's two possibilities," Red replied. "A mushrooming on the red can be caused by setting the red screen too high. You can't do this on all sets, but on some you can."

"What's the other reason?" Fuzzball asked.

"Low emission," Red stated. "When a color picture tube gets near the end of its useful life, you will often see the red beam begin to mushroom."

"It really had me stopped," Fuzz said. "It's one of those deals that I just couldn't figure."

"Well, it's not a simple matter. Something like that will stop about anybody the first time."

"I suppose if the emission is low, you can't do anything about it," Fuzzball suggested.

"I wouldn't say that," Red corrected him. "Just like in a black-and-white picture tube, you can sometimes get a little more service by using a booster."

"If I was old Fatpants, I'd tie a can on your tails," Bess advised them.

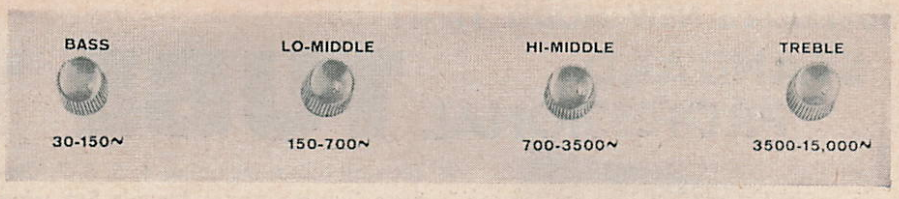
"Why would you do a thing like that?" Fuzzball asked.

"Do you guys take a coffee-break or a vacation?" she demanded.

"Bess is right," Red agreed. "We better get on our horse and shovel off."

Fuzzball slipped a dime under his saucer, with a guilty look.

"Are you sure you can spare it?" Bess snapped after him. END



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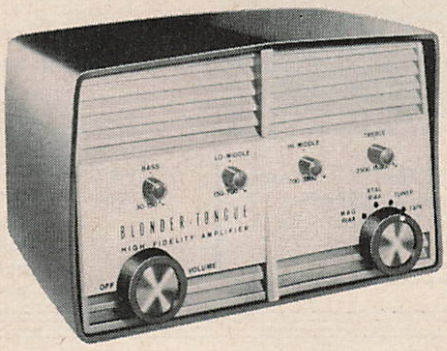

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A unique B-T Development! The Model A-1 Audio Amplifier divides the audible spectrum into its *four* significant segments (BASS, LO-MIDDLE, HI-MIDDLE and TREBLE.) *Four* separate tone controls permit you to boost or attenuate any frequency range or combination of ranges. The result—a degree of tonal selectivity unobtainable *anywhere* in the amplifier field. Solo instrumentalists or vocalists may be drawn out of the orchestral background to take their places in front of the orchestra. Correction for poor room acoustics, or for deficiencies in associated equipment, is instant and exact. Power output is 12 watts (music wave forms).

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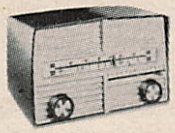

Model T-88 FM-AM Tuner—Amazing sensitivity on FM and AM. Frequency response, 20—20,000 cycles. Built-in FM antenna, with provision for external antenna. Built-in ferrite AM antenna. Simple, plug-in connection with A-1 amplifier for existing phonograph or TV receiver. Accurate and stable slide-rule tuning. **64.50**

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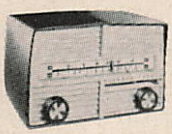

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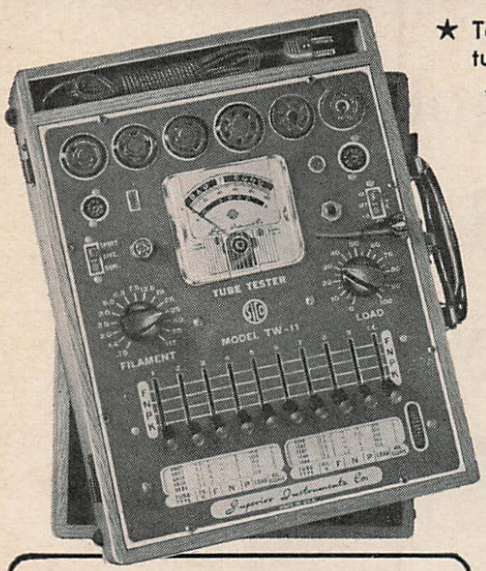
SUPERIOR'S NEW MODEL TW-11

STANDARD PROFESSIONAL TUBE TESTER



★ Tests all tubes, including 4, 5, 6, 7, Octal, Lock-in, Hearing Aid, Thyratron, Miniatures, Sub-miniatures, Novals, Sub-minars, Proximity fuse types, etc.

★ Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the RMA base numbering system, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TW-11 as any of the pins may be placed in the neutral position when necessary.

★ The Model TW-11 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in the wrong socket.

★ Free-moving built-in roll chart provides complete data for all tubes. All tube listings printed in large easy-to-read type.

★ NOISE TEST: Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.

EXTRAORDINARY FEATURE

SEPARATE SCALE FOR LOW-CURRENT TUBES. Previously, on emission-type tube testers, it has been standard practice to use one scale for all tubes. As a result, the calibration for low-current types has been restricted to a small portion of the scale. The extra scale used here greatly simplifies testing of low-current types.

Model TW-11 — TUBE TESTER . . . Total Price $47.50 — Terms: $11.50 after 10 day trial, then $6.00 per month for 6 months.

The Model TW-11 operates on 105-130 Volt 60 Cycles A.C. Comes housed in a beautiful hand-rubbed oak cabinet complete with portable cover.

$47.50 NET

SUPERIOR'S NEW MODEL 82

Multi-Socket Type

TUBE TESTER

TEST ANY TUBE IN 10 SECONDS FLAT!

(1) Turn the filament selector switch to position specified. (2) Insert tube into a numbered socket as designated on our chart (over 600 types included). (3) Press down the quality button —

***THAT'S ALL!* Read emission quality direct on bad-good meter scale.**

Model 82 — TUBE TESTER . . . Total Price $36.50 — Terms: $6.50 after 10 day trial, then $6.00 monthly for 5 months.

Production of this Model was delayed a full year pending careful study by Superior's engineering staff of this new method of testing tubes. Don't let the low price mislead you! We claim Model 82 will outperform similar looking units which sell for much more — and as proof, we offer to ship it on our examine before you buy policy.

Primarily, the difference between the conventional tube tester and the multi-socket type is that in the latter, the use of an added number of specific sockets (for example, in Model 82 the noval is duplicated eight times) permits elimination of element switches thus reducing testing time and possibility of incorrect switch readings.

To test any tube, you simply insert it into a numbered socket as designated, turn the filament switch and press down the quality switch—THAT'S ALL! Read quality on meter. Inter-element leakage, if any indicates automatically.

- Tests over 600 tube types.
- Tests 0Z4 and other gas-filled tubes.
- Employs new 4" meter with sealed air-damping chamber resulting in accurate vibrationless readings.
- Use of 22 sockets permits testing all popular tube types and prevents possible obsolescence.
- Dual Scale meter permits testing of low current tubes.
- 7 and 9 pin straighteners mounted on panel.
- All sections of multi-element tubes tested simultaneously.
- Ultra-sensitive leakage test circuit will indicate leakage up to 5 megohms.

Model 82 comes complete, housed in portable, hand-rubbed oak cabinet with removable cover. Only

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Try for 10 days before you buy! If completely satisfied, send down payment *after* trial and pay balance at indicated monthly rate — NO INTEREST OR FINANCE CHARGES ADDED. If not completely satisfied, return to us, no explanation necessary.

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SUPERIOR'S NEW MODEL 83

C.R.T. TESTER

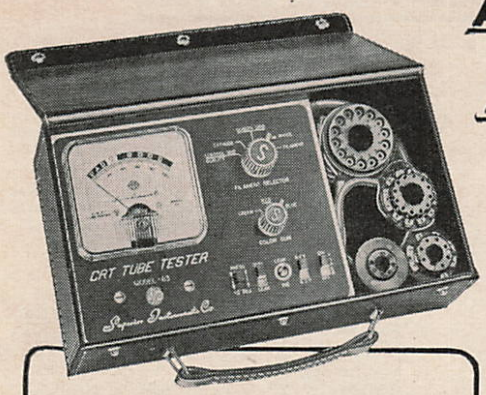
Tests and Rejuvenates ALL PICTURE TUBES

ALL BLACK AND WHITE TUBES

From 50 degree to 110 degree types—from 8" to 30" types.

ALL COLOR TUBES

Test ALL picture tubes—in the carton—out of the carton—in the set!



Model 83 — C.R.T. TUBE TESTER . . . Total Price $38.50 — Terms: $8.50 after 10 day trial, then $6.00 monthly for 5 months.

- Model 83 is *not* simply a rehashed black and white C.R.T. Tester with a color adapter added. Model 83 employs a new improved circuit designed specifically to test the older type black and white tubes, the newer type black and white tubes and all color picture tubes.
- Model 83 provides *separate* filament operating voltages for the older 6.3 types and the newer 8.4 types.
- Model 83 employs a 4" air-damped meter with quality and calibrated scales.
- Model 83 properly tests the red, green and blue sections of color tubes individually—for each section of a color tube contains its own filament, plate, grid and cathode.
- Model 83 will detect tubes which are apparently good but require rejuvenation. Such tubes will provide a picture seemingly good but lacking in proper definition, contrast and focus. To test for such malfunction, you simply press the rej. switch of Model 83. If the tube is weakening, the meter reading will indicate the condition.
- Rejuvenation of picture tubes is not simply a matter of applying a high voltage to the filament. Such voltages improperly applied can strip the cathode of the oxide coating essential for proper emission. The Model 83 applies a *selective* low voltage *uniformly* to assure increased life with no danger of cathode damage.

Model 83 comes housed in handsome portable Saddle Stitched Texon case— complete with sockets for all black and white tubes and all color tubes. Only **$38.50**

SUPERIOR'S NEW MODEL TV-12

TRANS-CONDUCTANCE TUBE TESTER

Model TV-12—TUBE TESTER . . . Total Price $72.50 — Terms: $22.50 after 10 day trial, then $10.00 monthly for 5 months.

TESTING TUBES

★ Employs improved TRANS-CONDUCTANCE circuit. An in-phase signal is impressed on the input section of a tube and the resultant plate current change is measured. This provides the most suitable method of simulating the manner in which tubes actually operate in Radio & TV receivers, amplifiers and other circuits. Amplification factor, plate resistance and cathode emission are all correlated in one meter reading.

★ NEW LINE VOLTAGE ADJUSTING SYSTEM. A tapped transformer makes it possible to compensate for line voltage variations to a tolerance of better than 2%.

★ SAFETY BUTTON — protects both the tube under test and the instrument meter against damage due to overload or other form of improper switching.

★ NEWLY DESIGNED FIVE POSITION LEVER SWITCH ASSEMBLY. Permits application of separate voltages as required for both plate and grid of tube under test, resulting in improved Trans-Conductance circuit.

TESTING TRANSISTORS

A transistor can be safely and adequately tested only under dynamic conditions. The Model TV-12 will test all transistors in that approved manner, and quality is read directly on a special "transistor only" meter scale.

The Model TV-12 will accommodate all transistors including NPN's, PNP's, Photo and Tetrodes, whether made of Germanium or Silicon, either point contact or junction contact types.

ALSO TESTS TRANSISTORS!

Model TV-12 housed in handsome rugged portable cabinet sells for only **$72.50 NET**

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VACUUM TUBE VOLTMETER

WITH NEW 6" FULL-VIEW METER

Compare it to any peak-to-peak V. T. V. M. made by any other manufacturer at any price!

- Model 77 completely wired and calibrated with accessories (including probe, test leads and portable carrying case) sells for only $42.50.
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- Model 77 meter is virtually burn-out proof. The sensitive 400 microampere meter is isolated from the measuring circuit by a balanced push-pull amplifier.
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AS AN AC VOLTMETER: Measures RMS values if sine wave, and peak-to-peak value if complex wave. Pedestal voltages that determine the "black" level in TV receivers are easily read.

AS AN ELECTRONIC OHMMETER: Because of its wide range of measurement leaky capacitors show up glaringly. Because of its sensitivity and low loading, intermittents are easily found, isolated and repaired.

SPECIFICATIONS

• **DC VOLTS** — 0 to 3/15/75/150/300/750/1,500 volts at 11 megohms input resistance. • **AC VOLTS (RMS)** — 0 to 3/15/75/150/300/750/1,500 volts. • **AC VOLTS** (Peak to Peak) — 0 to 8/40/200/400/800/2,000 volts. • **ELECTRONIC OHMMETER** — 0 to 1,000 ohms/10,000 ohms/100,000 ohms/1 megohm/10 megohms/100 megohms/1,000 megohms. • **DECIBELS** —10 db to + 18 db, + 10 db to + 38 db, + 30 db to + 58 db. All based on 0 db = .006 watts (6 mw) into a 500 ohm line (1.73v). • **ZERO CENTER METER** — For discriminator alignment with full scale range of 0 to 1.5/7.5/37.5/75/150/375/750 volts at 11 megohms input resistance.

Model 77 — VACUUM TUBE VOLTMETER... Total Price $42.50 — Terms: $12.50 after 10 day trial, then $6.00 monthly for 5 months.

Model 77 comes complete with operating instructions, probe and test leads. Use it on the bench—use it on calls. A streamlined carrying case, included at no extra charge, accommodates the tester, instruction book, probe and leads. Operates on 110-120 volt 60 cycle. Only .....

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SUPERIOR'S NEW MODEL 79

SUPER-METER — WITH NEW 6" FULL-VIEW METER

A Combination VOLT-OHM MILLIAMMETER.

Plus CAPACITY, REACTANCE, INDUCTANCE AND DECIBEL MEASUREMENTS.

Also Tests SELENIUM AND SILICON RECTIFIERS, SILICON AND GERMANIUM DIODES.

The Model 79 represents 20 years of continuous experience in the design and production of SUPER-METERS, an exclusive SICO development.

In 1938 Superior Instruments Co. designed its first SUPER-METER, Model 1150. In 1940 it followed with Model 1250 and in succeeding years with others including Models 670 and 670-A. All were basically V.O.M.'s with extra services provided to meet changing requirements.

Now, Model 79, the latest SUPER-METER includes not only every circuit improvement perfected in 20 years of specialization, but in addition includes those services which are "musts" for properly servicing the ever increasing number of new components used in all phases of today's electronic production. For example with the Model 79 SUPER-METER you can measure the quality of selenium and silicon rectifiers and all types of diodes—components which have come into common use only within the past five years, and because this latest SUPER-METER necessarily required extra meter scale, SICO used its new full-view 6-inch meter.

Specifications

D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500.
A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000.
D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes.
RESISTANCE: 0 to 1,000/100,000 Ohms. 0 to 10 Megohms.
CAPACITY: 001 to 1 Mfd. 1 to 50 Mfd.
REACTANCE: 50 to 2,500 Ohms, 2,500 Ohms to 2.5 Megohms.
INDUCTANCE: .15 to 7 Henries, 7 to 7,000 Henries.
DECIBELS: —6 to +18, +14 to +38, +34 to +58.

The following components are all tested for QUALITY at appropriate test potentials. Two separate BAD-GOOD scales on the meter are used for direct readings.

All Electrolytic Condensers from 1 MFD to 1000 MFD.
All Selenium Rectifiers. **All Germanium Diodes.**
All Silicon Rectifiers. **All Silicon Diodes.**

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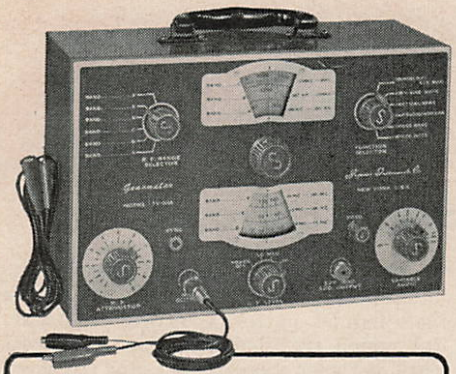
SUPERIOR'S NEW MODEL TV-50A

GENOMETER

7 Signal Generators in One!



- √ R.F. Signal Generator for A.M.
- √ R.F. Signal Generator for F.M.
- √ Audio Frequency Generator
- √ Bar Generator
- √ Cross Hatch Generator
- √ Color Dot Pattern Generator
- √ Marker Generator

A versatile all-inclusive GENERATOR which provides ALL the outputs for servicing:

A.M. Radio • F.M. Radio • Amplifiers • Black and White TV • Color TV

Model TV-50A GENOMETER . . . Total Price $47.50 — Terms: $11.50 after 10 day trial, then $6.00 monthly for 6 months.

Specifications

R. F. SIGNAL GENERATOR: The Model TV-50A Genometer provides complete coverage for A.M. and F.M. alignment. Generates Radio Frequencies from 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 180 Megacycles on powerful harmonics.

VARIABLE AUDIO FREQUENCY GENERATOR: In addition to a fixed 400 cycle sine-wave audio, the Model TV-50A Genometer provides a variable 300 cycle to 20,000 cycle peaked wave audio signal.

The Model TV-50A comes complete with shielded leads and operating instructions. Only

BAR GENERATOR: The Model TV-50A projects an actual Bar Pattern on any TV Receiver Screen. Pattern will consist of 4 to 16 horizontal bars or 7 to 20 vertical bars.

CROSS HATCH GENERATOR: The Model TV-50A Genometer will project a cross-hatch pattern on any TV picture tube. The pattern will consist of non-shifting, horizontal and vertical lines interlaced to provide a stable cross-hatch effect.

DOT PATTERN GENERATOR (FOR COLOR TV) Although you will be able to use most of your regular standard equipment for servicing Color TV, the one addition which is a "must" is a Dot Pattern Generator. The Dot Pattern projected on any color TV Receiver tube by the Model TV-50A will enable you to adjust for proper color convergence.

MARKER GENERATOR: The Model TV-50A includes all the most frequently needed marker points. The following markers are provided: 189 Kc., 262.5 Kc., 456 Kc., 600 Kc., 1000 Kc., 1400 Kc., 1600 Kc., 2000 Kc., 2500 Kc., 3579 Kc., 4.5 Mc., 5 Mc., 10.7 Mc., (3579 Kc. is the color burst frequency).

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SUPERIOR'S NEW MODEL 76

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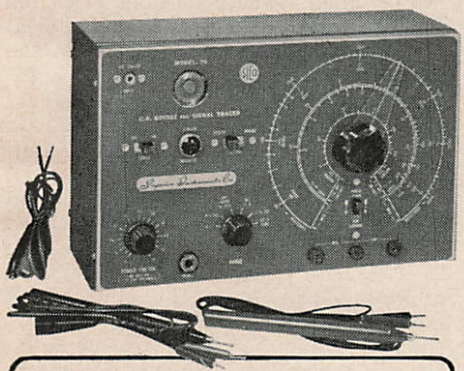

Model 76 . . . Total Price $26.95 — Terms: $6.95 after 10 day trial, then $5.00 monthly for 4 months.

IT'S A CONDENSER BRIDGE

with a range of .00001 Microfarad to 1000 Microfarads (Measures power factor and leakage too.)

IT'S A SIGNAL TRACER

which will enable you to trace the signal from antenna to speaker of all receivers and to finally pinpoint the exact cause of trouble whether it be a part or circuit defect.

CAPACITY BRIDGE SECTION

4 Ranges: .00001 Microfarad to 1000 Microfarads. Will also locate shorts and leakages up to 20 megohms. Measures the power factor of all condensers from .1 to 1000 Microfarads. (Power factor is the ability of a condenser to retain a charge and thereby filter efficiently.)

SIGNAL TRACER SECTION

With the use of the R.F. and A.F. Probes included with the Model 76, you can make stage gain measurements, locate signal loss in R.F. and Audio stages, localize faulty stages, locate distortion and hum, etc. Provision has been made for use of phones and meter if desired.

IT'S A RESISTANCE BRIDGE

with a range of 100 ohms to 5 megohms

IT'S A TV ANTENNA TESTER

The TV Antenna Tester section is used first to determine if a "break" exists in the TV antenna and if a break does exist the specific point (in feet from set) where it is.

RESISTANCE BRIDGE SECTION

2 Ranges: 100 ohms to 5 megohms. Resistance can be measured without disconnecting capacitor connected across it. (Except, of course, when the R C combination is part of an R C bank.)

TV ANTENNA TESTER SECTION

Loss of sync., snow and instability are only a few of the faults which may be due to a break in the antenna, so why not check the TV antenna first? 2 Ranges: 2′ to 200′ for 72 ohm coax and 2′ to 250′ for 300 ohm ribbon.

$26.95 NET

Model 76 comes complete with all accessories including R.F. and A.F. Probes; Test Leads and operating instructions. Nothing else to buy. Only

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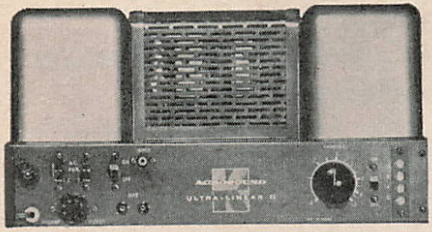
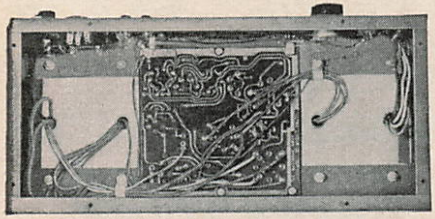
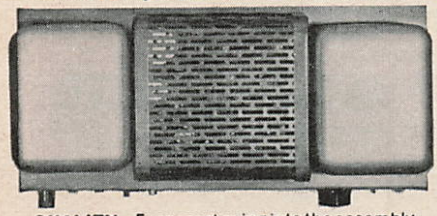


DESIGN The combination of patented ULTRA-LINEAR circuitry—plus new HYBRID FEEDBACK principle—VARIABLE DAMPING control, and ULTRA STABILITY, represents a new high in the art of amplifier design . . . an example of ACROSOUND'S latest achievement in AMERICAN Know-How. This superiority of design now enables anyone with or without any previous knowledge of electronics to assemble for himself or herself . . . (yes! it's that easy!) . . . the finest of amplifiers and at a most reasonable cost, in only two hours!



PERFORMANCE By listening test, or by instruments . . . second to none in clarity and frequency response. Normal level distortion is virtually unmeasurable—IM 1% or less at 60 watts, 120 watts peak. Completely stable . . . unaffected by loads, perfect square waves.



QUALITY Every part going into the assembly of critical and even non-critical circuitry is tested and checked to allow no more than ±½% variation from ACROSOUND'S standards. Specialized test equipment unavailable commercially was designed in ACROSOUND'S laboratories to achieve this result. Every printed circuit board is placed in trial operation on a laboratory amplifier. Output tubes are matched by trial and double checked.

COMPONENTS ACRO'S newest TO-600 output transformer with special hybrid winding—separates functions of output circuit and feedback circuit. Heavy duty, completely assembled, and thoroughly tested, printed circuit board assures uniformity of perform-

tv dx in '58

By ROBERT B. COOPER, JR.

THIS year, more than 900 completed TV dx report forms were returned to RADIO-ELECTRONICS. On these reports are more than 15,500 dx loggings, including 507 television stations in 48 states and 13 countries. Reports arriving on unofficial report forms accounted for an additional 4,000-plus loggings which still have to be tabulated. The number of individual reports reached an all-time high.

From the preliminary accounting of the dx reports, several definite patterns appear for 1958. Sporadic E-skip openings were fewer in number, shorter in duration and smaller in scope than in the preceding 4 years. E skip bunched for the most part in the last 2 weeks of the two big skip months, June and July. No single area seemed to benefit more than others from E-skip openings, although the East and Midwest saw their greatest concentration of Es work during late July and early August, while the Western states got theirs in late June and early July.

One major point stands out in the reports. Percentage-wise, a much greater portion than in past years of the openings noted affected only channel 2 or 3. Skip was just not reaching as high in the TV channels as in 1956 or '57. This is important to FM dxers, who must bide their time until the TV band opens into channel 6 before they can begin to "hear" any E skip. Supporting our observations, Bruce Elving, reporting from Duluth, Minn., heard just one case of E skip on the FM band all summer, and this was noted on the late date of Aug. 30.

Tropospheric conditions conducive to "super dx" (ground wave beyond 500 miles) formed only occasionally during the entire year. The usual good months of June, July and August did provide a few good openings but tropospheric loggings in excess of 500 miles number less than 75 for the entire season.

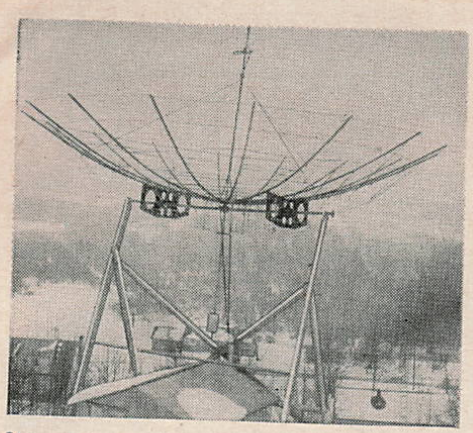
Tropospheric openings also fell into well-defined patterns during the year. Dx which traveled along an east–west path between transmitter and receiver was strictly a June–July phenomenon, as the warm air masses followed hot dry zones eastward from the western plains of Canada.

During August and September, the moist warm-air masses moved from the Gulf of Mexico into the eastern half of the country. This south-to-northeast air movement produced good tropospheric conditions along the Atlantic Coast and, often as not, well inland to the Mississippi River. As these humid masses of air moved into our populous Northeast, tropospheric conditions over north–south paths improved markedly.

One of the better periods for north–south tropospheric dx reported by many observers was the early morning hours of Aug. 31. John Cody of Middletown, Conn., found conditions from the Eastern seaboard very good as the local stations left the air. Digging into the snow barrier, he found WRAL-TV channel 5, Raleigh, N. C., 517 miles; WITN, channel 7, Washington, N. C., 480 miles; WNCT, channel 9, Greenville, N. C., 490 miles; WTVD, channel 11, Durham, N. C., 520 miles, and WLVA, channel 13, Lynchburg, Va., 450 miles, among a dozen more in the 250–400-mile range. Melvyn Sulzburgh of Philadelphia found the same period interesting when he intercepted WECT, channel 6, Wilmington, N. C., 420 miles, following the local channel 6 signoff.

Auroral trops?

For some time I have believed that there is a definite relationship between auroral displays (and the resulting aurora-E reflections of TV signals) and improved ground-wave conditions in the Great Lakes region. Time and time again, we have witnessed an apparent



One enterprising dxer, Stan Hosken of North Bay, Ontario, uses this 30-foot parabolic antenna. Changing the resonant dipoles lets him use the dish for any frequency from 40 to 1,000 mc.

correlation between these two decidedly different forms of signal propagation. Past reports hinting at a connection between the two were quite local in nature, usually involving one or two observers reporting dx suddenly picking up in a single direction and ending just as abruptly following a 2 to 3-hour auroral session.

This fall's big aurora came on Sept. 4, with visual displays seen into central Florida. Carl Boecher of Milwaukee, Wis., found the TV channels fairly jumping with hazy sliding lines, indicative of Northern Lights activity, at 2310 hours. From 2330 to 0005 hours on the 5th he discovered excellent quality signals from CFPL-TV, channel 10, London, Ont., 375 miles; CHCH-TV, channel 11, Hamilton, Ont., 450 miles; WWJ-TV, channel 4, WJBK-TV, channel 2, 300 miles, and WXYZ-TV, channel 7, all from Detroit, Mich. These tropospheric signals had not been present prior to the auroral-TV display.

No South Americans

This year was the first in several that we haven't received at least one report of reception of our Latin American neighbors south of Mexico City. Stations in El Salvador, Guatemala, Venezuela, Brazil and other South American countries did not appear a single time in the 15,500 tabulated dx loggings. One rare one did show up, however, when James Abercrombie of Columbia, S. C., caught HIT-TV, channel 2 from the Dominican Republic, on Aug. 12.

Cuban stations continued to forge toward the top of the list, with eastern dxers in the Middle Atlantic states seeing them most often. However, there are still some dxers who fail to recognize them for what they are. Cuban stations usually belong to one of two networks, and the networks use as their station break insignia the call letters assigned to the network origination station. Thus the CMQ network with its headquarters station in Havana (on channel 6) may show the call CMQ on many other channels. On the other hand, Telemundo (Cuba's second network) alternates its call slide with the

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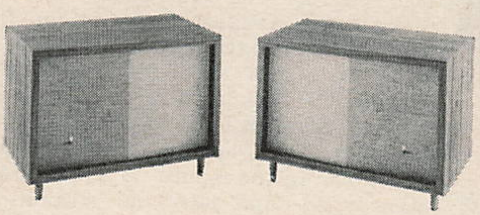

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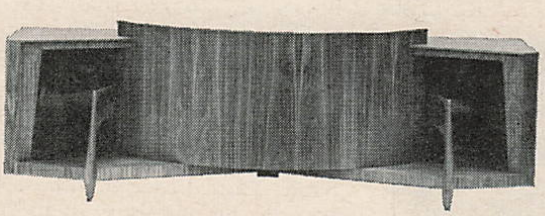
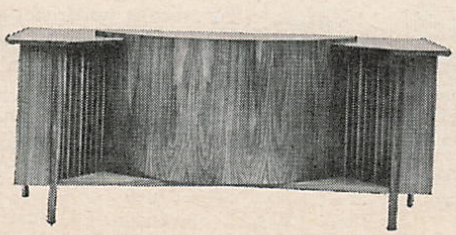


The JBL Ranger-Paragon is the ultimate stereo speaker system. Developed as a master monitor for use in perfecting stereo recording techniques, the Paragon adds to twin folded horns and professional driver units a radial refraction panel which integrates the two sound sources and disperses true stereo throughout the room.



The JBL Ranger-Metregon incorporates the virtues of radial refraction in an enclosure of acceptable size for the average living room. No hole in the middle, no split soloists, but sound reproduction spatially proportional to its original source. The Metregon accepts seven different speaker system combinations; can be upgraded progressively.

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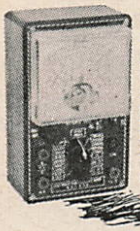
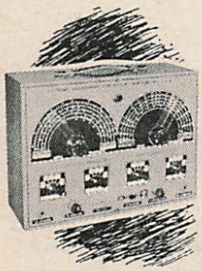


Model 102 Volometer
Features a 3½", 2% accurate—800 microamperes D'arsonval-type plastic front meter with 3 AC current ranges; and the same zero adjustment for both resistance ranges. Specifications . . . AC Voltage—5 Ranges: 0 to 12-120-600-1200-3000 volts. DC Voltage—5 Ranges: 0 to 6-60-300-600-3000 volts. AC Current—3 Ranges: 0 to 30-150-600 ma. DC Current—4 Ranges: 0 to 6-30-130 ma. 0 to 1.2 amps. Two Resistance Ranges: 0 to 1000 ohms, 0 to 1 megohms. **Model 102**, Wt. 1 lb. 5 oz. Size: 3¾" x 6¼" x 2". **$14.90**; Kit, **$12.50.**

Model 204 Tube-Battery-Ohm Capacity Tester
Emission tube tester. Completely flexible switching arrangement. Checks batteries under rated load on "reject-good" scale. Checks condenser leakage to 1 meg. Checks resistance up to 4 megs. Checks capacity from .01 to 1 mfd. **Model 204P**, illustrated. **$55.90. Model CRA**, Cathode ray tube adaptor, **$4.50.**



Model 700 RF-AF Crystal Marker TV Bar-Generator
Complete coverage from 18 cycles to 108 megacycles on fundamentals. Bar generator for TV adjustment with a variable number of bars available for horizontal or vertical alignment. Square wave generator to 20 kilocycles. Wien Bridge AF oscillator with sine wave output from 18 cycles to 300 kilocycles. Crystal marker and amplitude control. Individually tuned coils. Constant RF output impedance. Stepped RF attenuator. Variable percentage of modulation. **Model 700 ..... $55.90**

Model 205 Tube Tester
Uses standard emission test. Tests all tubes including Noval and subminiatures. Completely flexible switching arrangement. Checks for shorts, leakages and opens. **Model 205P**, Hand rubbed oak carrying case, **$47.50** (illustrated); Kit, **$36.20. Model CRA**, Cathode ray tube adaptor, **$4.50.**

Model 104 Volometer
Features a 4½", 50 microampere meter, with 3 AC current ranges and 3 resistance ranges to 20 megohms. Specifications . . . DC Voltage: 5 ranges (20,000 ohms per volt): 0 to 6-60-300-600-3000 volts. AC Voltage: 5 ranges (1,000 ohms per volt): 0 to 6-60-300-600-3000 volts. DC Current—3 Ranges: 0 to 6-60-600 ma. AC Current—3 Ranges: 0 to 30-300 ma. 0 to 3 amps. 3 Resistance Ranges: 0 to 20K, 0 to 200K, 0 to 20 megs. 5 DB Ranges: —4 to +67 DB. **Model 104**, with carrying strap; Wt. 2 lbs. 5 oz. Size: 5¼" x 6¾" x 2⅛", **$26.95**; Kit, **$19.95.** Model HVT, 30,000 volt probe for Model 104, **$7.95.**

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TELEVISION

individual station call letters. So there is only one rule of thumb to follow: Call letters which begin with CM are definitely from Cuba.

While we are out of the United States and in Southern waters, two more reports of special interest come to light. Enrique Veazey reports from Ciudad del Carmen, a small island in the southwestern corner of the Gulf of Mexico. Using a 17-inch Herald receiver and a 32-element stacked array, he views with *absolute regularity* reception from sta-

State hunters all over the US regard this one essential to their totals. KID-TV, channel 3, Idaho Falls, Idaho, as seen by B. J. Bingham, Festus, Mo.

tions all along the Gulf coast of Texas. Nothing unusual about all of this, except . . . these stations are 700 to 800 miles away! Oh yes, can anyone help him get rid of the snow which appears in the picture each evening between 1600 and 1900 hours?

Although Arnaloo Coro, Jr. of Havana doesn't have as regular results with dx across the Gulf as Enrique Veazey, he does note with some pride signals from KTRK-TV, channel 13, Houston, Tex., some 950 miles to the west, during the month of April. Many other high- and low-band stations in Louisiana, Alabama and Florida were also logged with great frequency during the spring months.

Still outside the country, but now to the north, Ross Harvey of Goose Bay, Labrador, found that TV dx holds thrills for isolated fans as well as those surrounded by TV stations. Ross even goes so far as to state, "I am a ham myself, VO2RH, and I am not ashamed to say it's more fun to TV dx than to ham!" Ross' broad-banded low-band Yagi brought him some 30 dx stations by mid-July, including KTWO-TV, channel 2, Casper, Wyo., a nice haul in any log.

Uhf dx

Uhfers (TV dxers with more than the average interest in uhf dx) increased during the year, possibly due to the poor Es season, allowing more time to keep an eye on the uhf band. John T. Sowders, Jr. of Richmond, Ky., has 24 uhf stations to his credit with 21 of these more than 175 miles distant. Two (WXIX, channel 19, Milwaukee; WTVO, channel 13, Rockford, Ill.) are beyond the 400-mile mark.

Roderick Luoma of Detroit finds that three very strong locals can crimp your style on the vhf spectrum, so he concentrates his efforts on the uhf chan-

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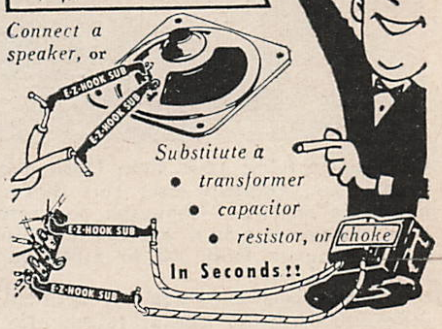

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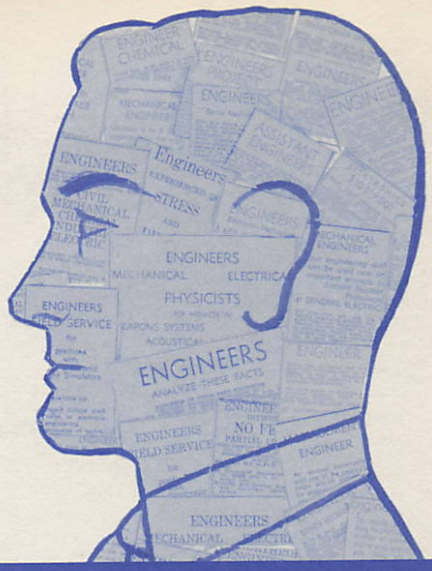

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nels. He finds that the uhf band is alive with dx much more often than most would think, especially during the summer months. Frequent reception in the 200 to 350-mile range is possible, if the observer is aware of the potentials.

FM totals

Although a goodly number of dxers are reporting FM dx as part of their regular dxing activities, we do not feel that sufficient totals are in for a summary at this time. Therefore, will FM dxers with more than 50 FM stations to their credit please submit totals to this column for an early tabulation. Included in the summary will be: farthest dx received (with date and time), number of states received, number of stations received daily, total number of stations and a rundown on the equipment being used.

Dxer extraordinaire

In the past years we have devoted this portion of the Annual TV dx review to the dxer who leads the pack with the greatest total number of stations. This year we will not.

As so much of the TV dxing group is interested in amassing huge station totals and extending dxing records, I wonder why we haven't had more "do-it-yourselfness" in the hobby. Erecting large antenna arrays, souping up receivers, installing ultra-low-loss feed lines are all readymade activities for the TV dx enthusiast. Unfortunately, few dxers seem to have any desire for anything more than a three-stage if 17-inch receiver of production-line design, and a single-bay all-channel Yagi.

One of the first exceptions to this rule that I encountered in 8 years of TV dxing is the subject for this year's review. Stan Hosken of North Bay, Ontario, has been experimenting with huge antenna arrays and souped-up receivers for 5 years. Prior to the installation of a local station in North Bay, Stan was developing a community antenna system, using sixteen 18-element Yagis, stacking 8 Yagis over 8, some 60 feet above ground. This 288-element array provided snow-free reception from Buffalo stations better than 95% of the time, over a 300-mile path.

When a local TV outlet spoiled his community distribution plans, Stan began work on a huge 30-foot parabola which rotates 360° horizontally, 180° vertically and is adjustable for operation at any point from 40 to 1,000 mc.

The array is mounted on an 8 x 8-foot building which rotates with the antenna. This building houses a portion of the receiving and testing equipment. The building is on a hill 400 feet above general terrain, in a very quiet residential location. All this makes for an excellent receiving setup, especially when used with the 288-element channel 4 array.

With the parabola, Stan is primarily interested in consistent reception from the nearest American stations, 300 to 400 miles away. At present, he is work-

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MARK II 50 watts $69.75* net

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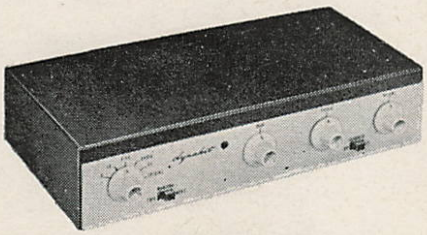
★ Handsome Styling — Selected for Display at Brussels World's Fair.
★ Only $34.95* net.



Power supply available for 2 pre-amplifiers PS-1 Kit $8.95* net

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★ Adds Complete Stereo Control To Two Preamps Without Noise or Distortion.
★ Unique Blend Control Fills In "Hole in Middle."
★ Level, Balance, Loudness, Channel Reverse, and Dual Tape Monitor Controls.
★ Only $12.95* net

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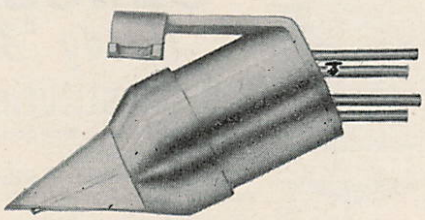
★ New completely symmetrical push pull magnetic pickup for either monophonic or stereo recordings.
★ High compliance in *all* directions permits tracking at 2 grams.
★ Smooth, peak-free response beyond 15kc with ideal channel separation and complete freedom from hum pick up.
★ With .7 mil replaceable diamond stylus for only $29.95.



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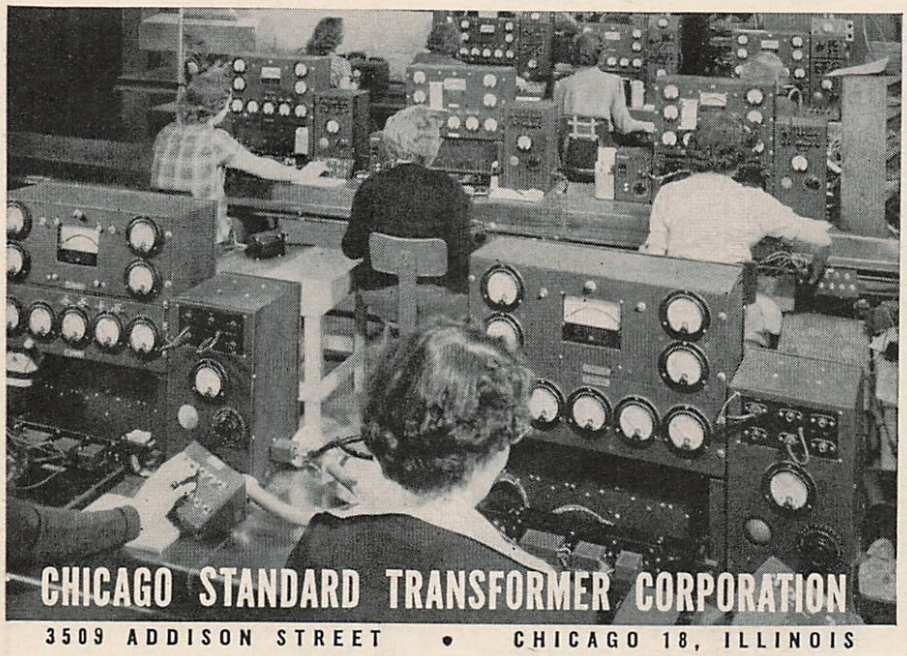

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TELEVISION

ing with a 350-mile uhf path, trying to develop it into some form of consistent reception.

Our hat is off to a real pioneer in a field that is all too often overrun with fellows obsessed with quantity and not the more important *quality*.

Over 50 TV Dx Club:

As TV dxers come and go, so do their ratings in the Over 50 club. Any reporters listed in last year's listing who do not appear in this year's totals may be assumed to be inactive. To maintain one's position in the over-50 listing, it is necessary to transmit no less than two reports per year to this column. It is with a great deal of sadness that we note many of the top dxers of 1954–57 are no longer active. On the bright side, however, this allows more new blood to push closer to the top of the Over 50 TV Dx Club.

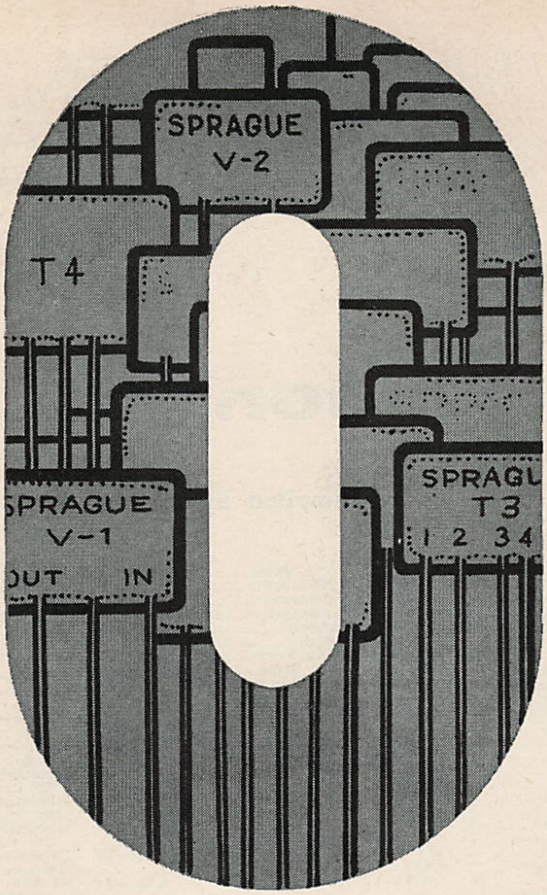
Name	Town	Stations	Best Dx Mileage	Uhf Total
Barney Rauch	Peoria, Ill.	263		
Frank Hill	Gallipolis, Ohio	246		
Kingdon P. Schafer	Kenmore, N.Y.	244	2,176	32
	Independence,			
David Janowiak	Milwaukee, Wis.	216	1,730	34
B. J. Bingham	Festus, Mo.	200	2,000	20
Ed Rugel	Kan.	197		
Richard V. Nieman	Buffalo, N.Y.	180	1,920	28
Bob Cooper*	Fresno, Calif.	168	6,600	8
John Cody	Middletown,			
	Conn.	165		11
Bill Eckberg	Walnut, Ill.	161		
Jim E. Himes	Joes, Colo.	159	4,075	
Ray F. Boyd	Zirconia, N.C.	150	2,300†	
Francis DeGroat	Salmanca, N.Y.	148		
R. H. Gordon	Harrisburg, Pa.	141	1,550	7
Ferdinand				
Dombrowski	Okauchee, Wis.	132	1,460	17
John T. Sowders	Richmond, Ky.	129	1,377	24
Milton C. Bay	Brooksville, Ky.	125	810†	34
Dibrell Ingram, Jr.	Conway, Ark.	125		
Stanley Penc	Utica, N. Y.	124	4,400	
M. W. DeGeer	Tulsa, Okla.	108		
Edwin Prond	Dolton, Ill.	108		24
Kenn Cooper	Fresno, Calif.	107	2,100	4
Jim Hines	Joes, Colo.	106		
Frank Wheeler	Erie, Pa.	106	2,117	9
Wayne Baer	Meyersdale, Pa.	105	1,400	4
Wesley H. White	New Albany, Ind.	100	1,250	5
Alexander H.				
Ladd, Jr.	Clearfield, Fla.	98	750†	1
Roger Brown	East Lansing,			
	Mich.	98		9
Gary Olson	Barrington, Ill.	96		
Ed Hepp	Portland, Ore.	95	2,900	
Donald Ruland	Holly Hill, Fla.	95		
Dick Mason	Menasha, Wis.	97	1,350	
Gary Rahn	Owen Sound, Ont.	94		
Ron Pugh	Fort Bragg,			
	Calif.	91		
Joseph Valetti	Monterrey,			
	Mexico	88	5,100	
Mr. & Mrs.				
W. L. Bush	Mexico, Mo.	87		
David Beal	Tucson, Ariz.	85	1,145	25
H. E. Apley	Akron, Ohio	84		22
Wayne Plunkett	Toronto, Ont.	81		
Morris Foote	Middletown, Id.	80		
Eddie Albright	Medford, Ore.	80	2,650	
Ronald A. Boyd	Truro, Nova			
	Scotia	78	3,000	
Rod Luoma	Detroit, Mich.	78		
John Black	Moffat, Ont.	77		
David Hanson	Washburn, Wis.	77	1,300	
Palmer Ewing	Lindsay, Calif.	76		
Dan Jones	Chester, Va.	75		
Joseph Tibiletti	Victoria, Tex.	75		
Rogert A. Greer	Auburn, Ill.	72		
John Kalb	Boonville, Mo.	70		
Merwyn Dowden	Chester, Va.	70		
Ed Davis	Champaign, Ill.	70	730‡	23
Bryan Rawlings	Montreal, Que.	68		
James Buchmann	La Crosse, Wis.	67		
David S. Roberts	Royal Oak, Mich.	67	1,125	14
DW Parsons	Florence, Ala.	66		
Carl Boecher	Milwaukee, Wis.	63		
Norris Doyle	Pittsburg, Calif.	62	2,350	2
Bert Nuber	Ft. Lauderdale,			
	Fla.	60		
George E. Oldham,	Johnson City,			
3rd	Tenn.	60	1,680	
Russell F. Schafer,	Junction City,			
3rd	Kan.	59		
David Novick	Shorewood, Wis.	58		
J. P. Boyle	Stratford, N.Y.	58		
Julius Boosi	South Bend, Ind.	57		
Richard J. Maguire	Haddon Heights,			
	N. J.	57	1,130	9
Tom Rathke	Clintonville, Wis.	56	1,210	
Richard Bergen,				
3rd	La Grange, Ky.	54		
Robert G. Brasseur	Saginaw, Mich.	53	1,657	
Harley Hurlburt	Bennington, Vt.	51	1,300	
Clark F. Conway	Knightstown, Ind.	51	1,200	
Barton Cronin	Ontario, Ore.	50		
Arnaloo Coro, Jr.	Havana, Cuba	50	950†	
James Abercrombie	Columbia, S. C.	50		
J. P. Boyle	Stratford, N.Y.	50		

* Vhf editor, Western Radio Amateur
† High band
‡ Uhf

END

now . . . . .

107



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vertical feedback networks
triode coupling networks
detector-pentode coupling networks
automatic gain control networks
horizontal deflection networks
sound i-f networks
vertical integrators
decoupling filters
audio output networks
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parallel resistor-capacitor networks
tone compensation networks
diode filters
pentode coupling networks
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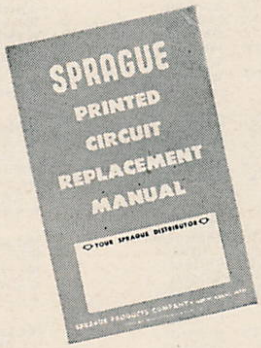

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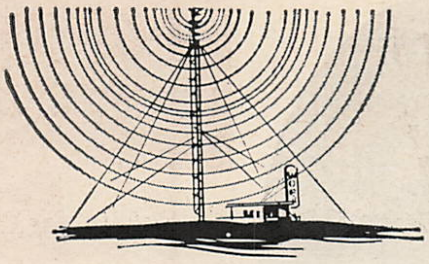


All stations in the United States and possessions, Canada and Mexico are listed, with location, call letters and channel number

Correct to Dec. 1, 1958

Television Station List

Compiled by MURIEL I. SCHILLER

Alabama

WAIQ	Andalusia	2
WAPI-TV	Birmingham	13
WBIQ	Birmingham	10
WBRC-TV	Birmingham	6
WMSL-TV	Decatur	23
WTVY	Dothan	9
WOWL-TV	Florence	15
WALA-TV	Mobile	10
WKRG-TV	Mobile	5
WCOV-TV	Montgomery	20
WSFA-TV	Montgomery	12
WTIQ	Munford	7

Alaska

KENI-TV	Anchorage	2
KTVA	Anchorage	11
KFAR-TV	Fairbanks	2
KTVF	Fairbanks	11
KINY-TV	Juneau	8

Arizona

KVAR	Mesa (Phoenix)	12
KOOL-TV	Phoenix	10
KPHO-TV	Phoenix	5
KTVK	Phoenix	3
KGUN-TV	Tucson	9
KOLD-TV	Tucson	13
KVOA-TV	Tucson	4
KIVA	Yuma	11

Arkansas

KTVE	El Dorado	10
KNAC-TV	Ft. Smith	5
KARK-TV	Little Rock	4
KTHV	Little Rock	11
KATV	Pine Bluff-Little Rock	7

California

KBAK-TV	Bakersfield	29
KERO-TV	Bakersfield	10
KHSL-TV	Chico	12
KIEM-TV	Eureka	3
KVIQ-TV	Eureka	6
KFRE-TV	Fresno	12
KJEO	Fresno	47
KMJ-TV	Fresno	24
KABC-TV	Los Angeles	7
KCOP	Los Angeles	13
KHJ-TV	Los Angeles	9
KNXT	Los Angeles	2
KRCA	Los Angeles	4
KTLA	Los Angeles	5
KTTV	Los Angeles	11
KTVU	Oakland	2
KVIP-TV	Redding	7
KBET-TV	Sacramento	10
KCCC-TV	Sacramento	40
KCRA-TV	Sacramento	3
KSBW-TV	Salinas-Monterey	8
KFMB-TV	San Diego	8
KFSD-TV	San Diego	10
KGO-TV	San Francisco	7
KPIX	San Francisco	5
KQED	San Francisco	9
KRON-TV	San Francisco	4
KNTV	San Jose	11
KSBY-TV	San Luis Obispo	6
KEY-T	Santa Barbara	3
KOVR	Stockton	13

Colorado

KKTV	Colorado Springs	11
KRDO-TV	Colorado Springs	13
KBTV	Denver	9
KLZ-TV	Denver	7
KOA-TV	Denver	4
KRMA-TV	Denver	6
KTVR	Denver	2
KREX-TV	Grand Junction	5
KREY-TV	Montrose	10
KCSJ-TV	Pueblo	5

Connecticut

WICC-TV	Bridgeport	43
WHCT	Hartford	18
WTIC-TV	Hartford	3
WNBC	New Britain-Hartford	30
WNHC-TV	New Haven-Hartford	8
WATR-TV	Waterbury	53

District of Columbia

WMAL-TV	Washington	7
WRC-TV	Washington	4
WTOP-TV	Washington	9
WTTG	Washington	5

Florida

WESH-TV	Daytona Beach	2
WINK-TV	Fort Myers	11
WFGA-TV	Jacksonville	12
WJCT	Jacksonville	7
WJXT	Jacksonville	4
WCKT	Miami	7
WPST-TV	Miami	10
WTHS-TV	Miami	2
WTVJ	Miami	4
WDBO-TV	Orlando	6
WLOF-TV	Orlando	9
WPTV	Palm Beach	5
WJDM	Panama City	7
WEAR-TV	Pensacola	3
WSUN-TV	St. Petersburg-Tampa	38
WEDU	Tampa-St. Petersburg	3
WFLA-TV	Tampa-St. Petersburg	8
WTVT	Tampa-St. Petersburg	13
WEAT-TV	W. Palm Beach	12

Georgia

WALB-TV	Albany	10
WAGA-TV	Atlanta	5
WETV	Atlanta	30
WLW-A	Atlanta	11
WSB-TV	Atlanta	2
WJBF	Augusta	6
WRDW-TV	Augusta	12
WRBL-TV	Columbus	4
WTVM	Columbus	28
WMAZ-TV	Macon	13
WSAV-TV	Savannah	3
WTOC-TV	Savannah	11
WCTV	Thomasville-Tallahassee	6

Guam

KUAM-TV	Agana	8

Hawaii

KHBC-TV	Hilo	9
KGMB-TV	Honolulu	9
KHVH-TV	Honolulu	4
KONA	Honolulu	2
KALA-TV	Wailuku	8
KMAU	Wailuku	3
KMVI-TV	Wailuku	12

Idaho

KBOI-TV	Boise	2
KIDO-TV	Boise	7
KID-TV	Idaho Falls	3
KLEW-TV	Lewiston	3
KLIX-TV	Twin Falls	11

Illinois

WCIA	Champaign	3
WILL-TV	Champaign-Urbana	12
WBBM-TV	Chicago	2
WBKB	Chicago	7
WGN-TV	Chicago	9
WNBQ	Chicago	5
WTTW	Chicago	11
WDAN-TV	Danville	24
WTVP	Decatur	17
WSIL-TV	Harrisburg	3
WEEQ-TV	La Salle	35
WEEK-TV	Peoria	43
WMBD-TV	Peoria	31
WTVH	Peoria	19
WGEM-TV	Quincy-Hannibal (Mo.)	10
WREX-TV	Rockford	13
WTVO	Rockford	39
WHBF-TV	Rock Island	4
WICS	Springfield	20

Indiana

WTTV	Bloomington-Indianapolis	4
WSJV	Elkhart-South Bend	28
WEHT	Evansville	50
WFIE-TV	Evansville	14
WTVW	Evansville	7
WANE-TV	Fort Wayne	15
WKJG-TV	Fort Wayne	33
WPTA	Fort Wayne	21
WFBM-TV	Indianapolis	6
WISH-TV	Indianapolis	8
WLWI	Indianapolis	13
WFAM-TV	Lafayette	59
WLBC-TV	Muncie	49
WNDU-TV	South Bend	16
WSBT-TV	South Bend	22
WTHI-TV	Terre Haute	10

Iowa

WOI-TV	Ames-Des Moines	5
KCRG-TV	Cedar Rapids	9
WMT-TV	Cedar Rapids	2
WOC-TV	Davenport	6
KRNT-TV	Des Moines	8
WHO-TV	Des Moines	13
KQTV	Fort Dodge	21
KGLO-TV	Mason City	3
KTIV	Sioux City	4
KVTV	Sioux City	9
KWWL-TV	Waterloo	7

Kansas

KTVC	Ensign	6
KWGB-TV	Goodland	10
KCKT	Great Bend	2
KAYS-TV	Hays	7
KTVH	Hutchinson	12
KOAM-TV	Pittsburg-Joplin (Mo.)	7
WIBW-TV	Topeka	13
KAKE-TV	Wichita	10
KARD-TV	Wichita	3

Kentucky

WKYT	Lexington	27
WLEX-TV	Lexington	18
WAVE-TV	Louisville	3
WFPK-TV	Louisville	15
WHAS-TV	Louisville	11
WPSD	Paducah	6

Louisiana

KALB-TV	Alexandria	5
WAFB-TV	Baton Rouge	28
WBRZ	Baton Rouge	2
KLFY-TV	Lafayette	10
KPLC-TV	Lake Charles	7
KTAG-TV	Lake Charles	25
KLSE	Monroe	13
KNOE-TV	Monroe	8
WDSU-TV	New Orleans	6
WJMR-TV	New Orleans	20
WWL-TV	New Orleans	4
WYES	New Orleans	8
KSLA-TV	Shreveport	12
KTBS-TV	Shreveport	3

Maine

WABI-TV	Bangor	5
WLBZ-TV	Bangor	2
WMTW-TV	Poland Spring	8
WCSH-TV	Portland	6
WGAN-TV	Portland	13
WAGM-TV	Presque Isle	8

Maryland

WBAL-TV	Baltimore	11
WJZ-TV	Baltimore	13
WMAR-TV	Baltimore	2
WBOC-TV	Salisbury	16

Massachusetts

WCDC	Adams	19
WBZ-TV	Boston	4
WGBH-TV	Boston	2
WNAC-TV	Boston	7
WRLP	Greenfield	32
WHYN-TV	Springfield-Holyoke	40
WWLP	Springfield	22

Michigan

WNEM-TV	Bay City-Flint-Saginaw	5
WWTV	Cadillac	13
WJBK-TV	Detroit	2
WTVS	Detroit	56
WWJ-TV	Detroit	4
WXYZ-TV	Detroit	7
WJRT	Flint	12
WOOD-TV	Grand Rapids-Kalamazoo	8
WIRN	Ironwood	12
WKZO-TV	Kalamazoo	3
WJIM-TV	Lansing-Flint	6
WDMJ-TV	Marquette	6
WILX-TV	Onondaga	10
WKNX-TV	Saginaw-Bay City	57
WPBN-TV	Traverse City	7

Minnesota

KCMT	Alexandria	7
KMMT	Austin	6
KDAL-TV	Duluth-Superior	3
WDSM-TV	Duluth-Superior	6
KEYC-TV	Mankato	12
WCCO-TV	Minneapolis-St. Paul	4
WTCN-TV	Minneapolis-St. Paul	11
KMSP	Minneapolis-St. Paul	9
KSTP-TV	St. Paul-Minneapolis	5
KTCA-TV	St. Paul Minneapolis	2
KROC-TV	Rochester	10

Mississippi

WCBI-TV	Columbus	4
WDAM-TV	Hattiesburg	9
WJTV	Jackson	12
WLBT	Jackson	3
WTOK-TV	Meridian	11

Missouri

KFVS-TV	Cape Girardeau	12
KOMU-TV	Columbia	8
KHQA-TV	Hannibal-Quincy (Ill.)	7
KRCG	Jefferson City	13
KODE-TV	Joplin	12
KCMO-TV	Kansas City	5
KMBC-TV	Kansas City	9
WDAF-TV	Kansas City	4
KTVO	Kirksville-Ottumwa (Ia.)	3
KFEQ-TV	St. Joseph	2
KETC	St. Louis	9
KMOX-TV	St. Louis	4
KSD-TV	St. Louis	5
KTVI	St. Louis	2
KDRO-TV	Sedalia	6
KTTS-TV	Springfield	10
KYTV	Springfield	3

Montana

KGHL-TV	Billings	8
KOOK-TV	Billings	2
KXLF-TV	Butte	4
KXGN-TV	Glendive	5
KFBB-TV	Great Falls	5
KRTV	Great Falls	3
KXLJ-TV	Helena	12
KULR	Kalispell	9
KSMO-TV	Missoula	13

Nebraska

KHAS-TV	Hastings	5
KDUH-TV	Hay Springs	4
KHPL-TV	Hayes Center	6
KHOL-TV	Kearney-Holdrege	13
KOLN-TV	Lincoln	10
KUON-TV	Lincoln	12
KETV	Omaha	7
KMTV	Omaha	3
WOW-TV	Omaha	6
KSTF	Scottsbluff	10

Nevada

KLRJ-TV	Henderson-Las Vegas	2
KLAS-TV	Las Vegas	8
KSHO-TV	Las Vegas	13
KOLO-TV	Reno	8

New Hampshire

WMUR-TV	Manchester	9

New Jersey

WNTA-TV	Newark-New York (N.Y.)	13

New Mexico

KGGM-TV	Albuquerque	13
KNME-TV	Albuquerque	5
KOAT-TV	Albuquerque	7
KOB-TV	Albuquerque	4
KAVE-TV	Carlsbad	6
KICA-TV	Clovis	12
KSWS-TV	Roswell	8

New York

W-TEN	Albany	10
WTRI	Albany-Schenectady-Troy	35
WNBF-TV	Binghamton	12
WINR-TV	Binghamton	40
WBEN-TV	Buffalo	4
WGR-TV	Buffalo	2
WCNY-TV	Carthage-Watertown	7
WSYE-TV	Elmira	18
WABC-TV	New York	7
WCBS-TV	New York	2
WNEW-TV	New York	5
WOR-TV	New York	9
WPIX	New York	11
WRCA-TV	New York	4
WPTZ	Plattsburg	5
WHEC-TV	Rochester	10
WROC-TV	Rochester	5
WVET-TV	Rochester	10
WRGB	Schenectady	6
WHEN-TV	Syracuse	8
WSYR-TV	Syracuse	3
WKTV	Utica	13

North Carolina

WISE-TV	Asheville	62
WLOS-TV	Asheville	13
WUNC-TV	Chapel Hill	4
WBTV	Charlotte	3
WSOC-TV	Charlotte	9
WTVD	Durham-Raleigh	11
WFMY-TV	Greensboro	2
WNCT	Greenville	9
WRAL-TV	Raleigh-Durham	5
WITN	Washington	7
WECT	Wilmington	6
WSJS-TV	Winston-Salem	12

North Dakota

KBMB-TV	Bismarck	12
KFYR-TV	Bismarck	5
KDIX-TV	Dickinson	2
WDAY-TV	Fargo	6
KNOX-TV	Grand Forks	10
KMOT	Minot	10
KXMC-TV	Minot	13
KXJB-TV	Valley City	4
KUMV-TV	Williston	8

Ohio

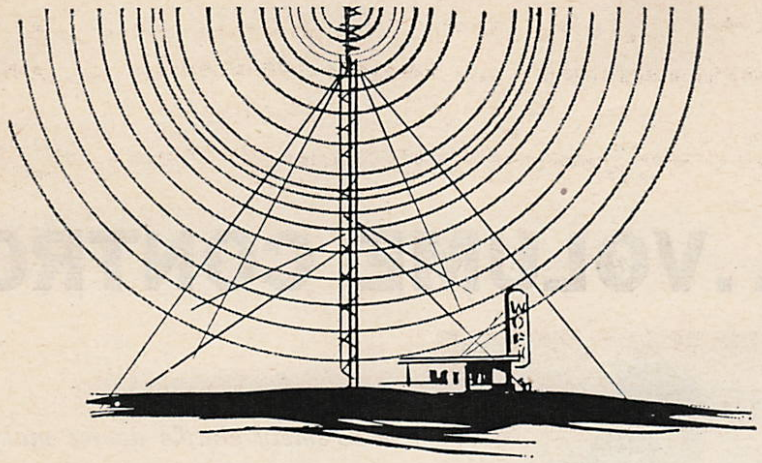
WAKR-TV	Akron	49
WCET	Cincinnati	48
WCPO-TV	Cincinnati	9
WKRC-TV	Cincinnati	12
WLWT	Cincinnati	5
KYW-TV	Cleveland	3
WEWS	Cleveland	5
WJW-TV	Cleveland	8
WBNS-TV	Columbus	10
WLW-C	Columbus	4
WOSU-TV	Columbus	34
WTVN-TV	Columbus	6
WHIO-TV	Dayton	7
WLW-D	Dayton	2
WIMA-TV	Lima	35
WSTV-TV	Steubenville-Wheeling (W.Va.)	9
WSPD-TV	Toledo	13
WFMJ-TV	Youngstown	21
WKBN-TV	Youngstown	27
WKST-TV	Youngstown	45
WHIZ-TV	Zanesville	18

Oklahoma

KTEN	Ada	10
KVSO-TV	Ardmore	12
KOCO	Enid-Oklahoma City	5
KETA	Oklahoma City	13
KWTV	Oklahoma City	9
WKY-TV	Oklahoma City	4
KOTV	Tulsa	6
KTUL-TV	Tulsa	8
KVOO-TV	Tulsa	2

Oregon

KOAC-TV	Corvallis	7
KVAL-TV	Eugene	13
KOTI	Klamath Falls	2



KBES-TV	Medford	5
KGW-TV	Portland	8
KOIN-TV	Portland	6
KPTV	Portland	12
KPIC	Roseburg	4

Pennsylvania

WFBG-TV	Altoona	10
WICU-TV	Erie	12
WSEE	Erie	35
WHP-TV	Harrisburg	55
WTPA	Harrisburg	27
WARD-TV	Johnstown	56
WJAC-TV	Johnstown	6
WGAL-TV	Lancaster	8
WLVH-TV	Lebanon	15
WBPZ-TV	Lock Haven	32
WKST-TV	New Castle-Youngstown (O.)	45
WCAU-TV	Philadelphia	10
WFIL-TV	Philadelphia	6
WHYY-TV	Philadelphia	35
WRCV-TV	Philadelphia	3
KDKA-TV	Pittsburgh	2
WIIC	Pittsburgh	11
WQED	Pittsburgh	13
WTAE	Pittsburgh	4
WDAU-TV	Scranton	22
WNEP	Scranton-Wilkes Barre	16
WBRE-TV	Wilkes-Barre	28
WSBA-TV	York	43

Puerto Rico

WORA-TV	Mayaguez	5
WRIK-TV	Ponce	7
WSUR-TV	Ponce	9
WAPA-TV	San Juan	4
WIPR-TV	San Juan	6
WKAQ-TV	San Juan	2

Rhode Island

WJAR-TV	Providence	10
WPRO-TV	Providence	12

South Carolina

WAIM-TV	Anderson	40
WCSC-TV	Charleston	5
WUSN-TV	Charleston	2
WIS-TV	Columbia	10
WNOK-TV	Columbia	67
WBTW	Florence	8
WFBC-TV	Greenville	4
WSPA-TV	Spartanburg	7

South Dakota

KDLO-TV	Florence	3
KOTA-TV	Rapid City	3
KOSD-TV	Rapid City	7
KPLO-TV	Reliance	6
KELO-TV	Sioux Falls	11

Tennessee

WDEF-TV	Chattanooga	12
WRGP-TV	Chattanooga	3
WTVC	Chattanooga	9
WDXI-TV	Jackson	7
WJHL-TV	Johnson City	11
WATE-TV	Knoxville	6
WBIR-TV	Knoxville	10
WTVK	Knoxville	26
WHBQ-TV	Memphis	13
WKNO-TV	Memphis	10
WMCT	Memphis	5
WREC-TV	Memphis	3
WLAC-TV	Nashville	5
WSIX-TV	Nashville	8
WSM-TV	Nashville	4

Texas

KRBC-TV	Abilene	9
KFDA-TV	Amarillo	10
KGNC-TV	Amarillo	4
KVII	Amarillo	7
KTBC-TV	Austin	7
KFDM-TV	Beaumont	6
KEDY-TV	Big Spring	4
KBTX	Bryan	3
KRIS-TV	Corpus Christi	6
KZTV	Corpus Christi	10
KRLD-TV	Dallas	4
WFAA-TV	Dallas	8
KELP-TV	El Paso	13
KROD-TV	El Paso	4
KTSM-TV	El Paso	9
KFJZ-TV	Fort Worth	11
WBAP-TV	Fort Worth	5
KGBT-TV	Harlingen	4
KGUL-TV	Houston	11
KPRC-TV	Houston	2
KTRK-TV	Houston	13
KUHT	Houston	8
KHAD-TV	Laredo	8
KCBD-TV	Lubbock	11
KDUB-TV	Lubbock	13
KTRE-TV	Lufkin	9
KMID-TV	Midland	2
KTES	Nacogdoches	19
KOSA-TV	Odessa	7
KPAC-TV	Port Arthur-Beaumont	4
KCTV	San Angelo	8
KCOR-TV	San Antonio	41
KENS-TV	San Antonio	5
KONO-TV	San Antonio	12
WOAI-TV	San Antonio	4
KPAR-TV	Sweetwater-Abilene	12
KCEN-TV	Temple	6
KCMC-TV	Texarkana	6
KLTV	Tyler-Longview	7
KWTX-TV	Waco	10
KRGV-TV	Weslaco	5
KFDX-TV	Wichita Falls	3
KSYD	Wichita Falls	6

Utah

KSL-TV	Salt Lake City	5
KTVT	Salt Lake City	4
KUED	Salt Lake City	7
KUTV	Salt Lake City	2

Vermont

WCAX-TV	Burlington	3

Virginia

WCYB-TV	Bristol	5
WVEC-TV	Hampton-Norfolk	15
WSVA-TV	Harrisonburg	3
WLVA-TV	Lynchburg	13
WTAR-TV	Norfolk	3
WTOV-TV	Norfolk	27
WXEX-TV	Petersburg-Richmond	8
WAVY-TV	Portsmouth-Norfolk	10
WRVA-TV	Richmond	12
WTVR	Richmond	6
WDBJ	Roanoke	7
WSLS-TV	Roanoke	10

Washington

KVOS-TV	Bellingham	12
KBAS-TV	Ephrata	16
KTRX	Kennewick-Pasco	31
KEPR-TV	Pasco-Kennewick-Richland	19
KCTS	Seattle	9
KING-TV	Seattle	5
KIRO-TV	Seattle	7
KOMO-TV	Seattle	4
KHQ-TV	Spokane	6
KREM-TV	Spokane	2
KXLY-TV	Spokane	4
KTVW	Tacoma	13
KTNT-TV	Tacoma	11
KIMA-TV	Yakima	29

West Virginia

WHIS-TV	Bluefield	6
WCHS-TV	Charleston	8
WBOY-TV	Clarksburg	12
WHTN-TV	Huntington	13
WSAZ-TV	Huntington	3
WOAY-TV	Oak Hill	4
WTAP	Parkersburg	15
WTRF-TV	Wheeling	7

Wisconsin

WEAU-TV	Eau Claire	13
WBAY-TV	Green Bay	2
WFRV-TV	Green Bay	5
WKBT	La Crosse	8
WHA-TV	Madison	21
WISC-TV	Madison	3
WKOW-TV	Madison	27
WMTV	Madison	33
WMBV-TV	Marinette-Green Bay	11
WISN-TV	Milwaukee	12
WTMJ-TV	Milwaukee	4
WXIX	Milwaukee	18
WSAU-TV	Wausau	7
WITI-TV	Whitefish Bay-Milwaukee	6

Wyoming

KSPR-TV	Casper	6
KTWO-TV	Casper	2
KFBC-TV	Cheyenne	5
KWRB-TV	Riverton	10

Canada

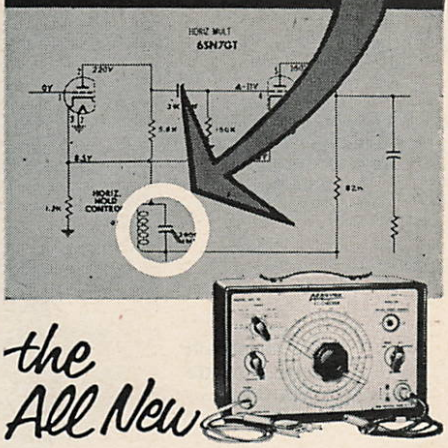
CHCT-TV	Calgary, Alta.	2
CFRN-TV	Edmonton, Alta.	3
CJLH-TV	Lethbridge, Alta.	7
CHAT-TV	Medicine Hat, Alta.	6
CHCA-TV	Red Deer, Alta.	6
CFCR-TV	Kamloops, B.C.	4
CHBC-TV	Kelowna, B.C.	2
CHBC-TV-1	Penticton, B.C.	13
CBUT	Vancouver, B.C.	2
CHBC-TV-2	Vernon, B.C.	7
CHEK-TV	Victoria, B.C.	6
CFLA-TV	Goose Bay, Labrador	8
CKX-TV	Brandon, Man.	5
CBWT	Winnipeg, Man.	3
CKCW-TV	Moncton, N.B.	2
CHSJ-TV	St. John, N.B.	4
CJOX-TV	Argentia, Nfld.	10
CFSN-TV	Stephenville, Nfld.	8
CJON-TV	St. John's, Nfld.	6
CBHT	Halifax, N.S.	3
CJCB-TV	Sydney, N.S.	4
CKVR-TV	Barrie, Ont.	3
CFCL-TV-2	Elk Lake, Ont.	2
CHCH-TV	Hamilton, Ont.	11
CFCL-TV-1	Kapuskasing, Ont.	3
CKWS-TV	Kingston, Ont.	11
CKCO-TV	Kitchener, Ont.	13
CFPL-TV	London, Ont.	10
CKGN-TV	North Bay, Ont.	10
CBOFT	Ottawa, Ont.	9
CBOT	Ottawa, Ont.	4
CHEX-TV	Peterborough, Ont.	12
CFPA-TV	Port Arthur, Ont.	2
CJIC-TV	Sault Ste. Marie, Ont.	2
CKSO-TV	Sudbury, Ont.	5
CFCL-TV	Timmins, Ont.	6
CBLT	Toronto, Ont.	6
CKLW-TV	Windsor, Ont.	9
CKNX-TV	Wingham, Ont.	8
CFCY-TV	Charlottetown, P.E.I.	13
CJES-TV-1	Estcourt, Que.	70
CKRS-TV	Jonquiere, Que.	12
CKBL-TV	Matane, Que.	9
CBFT	Montreal, Que.	2
CBMT	Montreal, Que.	6
CFCM-TV	Quebec City, Que.	4
CKMI-TV	Quebec City, Que.	5
CJBR-TV	Rimouski, Que.	3
CHLT-TV	Sherbrooke, Que.	7
CKTM-TV	Trois Rivieres, Que.	13
CKCK-TV	Regina, Sask.	2
CFQC-TV	Saskatoon, Sask.	8
CKOS-TV	Yorkton, Sask.	3

Mexico

XERA-TV	Chihuahua, Chihuahua	11
XEJ-TV	Juarez, Chihuahua	5
XEM-TV	Mexicali, Baja California	3
XEW-TV	Mexico City, D.F.	2
XHGC-TV	Mexico City, D.F.	5
XHTV	Mexico City, D.F.	4
XHNL-TV	Monterrey, Nuevo Leon	10
XEQ-TV	Paso de Cortes (Altzomoni)	9
XEX-TV	Paso de Cortes (Altzomoni)	7
XEZ-TV	Queretaro, Queretaro	3
XETV	Tijuana, Baja California	6

END

can your present test equipment check this capacitor in circuit?



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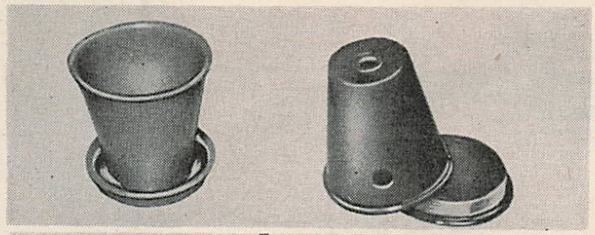
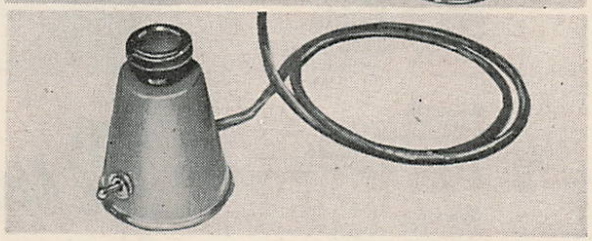
REMOTE.....VOLUME CONTROL



Flower pot is modified by drilling a hole in its side and bottom.



The completed remote volume control.

Extremely simple device makes for comfortable listening

By HAROLD REED

NOT so long ago *Reader's Digest* published a story about an advertising executive who placed on the market a gadget, appropriately called Blab-off, to cut off objectionable television commercial advertising. This little gadget is nothing more than a switch mounted in a suitable container, a two-pair flexible cable with a simple arrangement for connecting into the television set and instructions explaining how anyone may attach the device to the set. (The ad man even pointed out that anyone with a little knowledge of electronic circuitry could buy the few parts himself and make up and attach such a gadget.) All it does is open the loudspeaker voice-coil circuit when the offensive commercial begins and close it again when the blabbing ceases.

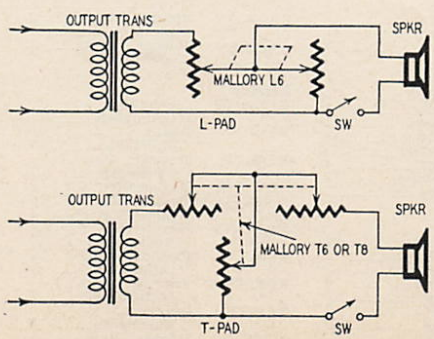
For a number of years I have tried various devices to eliminate obnoxious listening of any sort from a television program—a simple switch working like Blab-off and more complicated devices, some using photoelectric cells. All were useful and worth the time and effort put forth in their construction. However, they were all strictly of the on–off type.

Television stations at times seem to regard the audio portion of their transmission of secondary importance. On variety shows the viewer may have the sound level adjusted for comfortable listening volume on skits and other speaking portions of the show, only to have, a little later in the program, musical selections and vocal offerings blaring forth from the loudspeaker. Also, some commercial advertising is not offensive in itself but is shouted at the viewer at an annoyingly high level not in conformity with the sound level of the rest of the program. Therefore, I felt the need for more than just an on–off device.

A simple gadget for this purpose is shown in the diagrams. It not only cuts the sound on and off but provides volume control from the viewing position.

A constant-impedance variable-L or T attenuator is used. These pads are available in impedances of 6, 8 and 15 ohms. Most loudspeaker voice coils have an impedance somewhere between 6 and 15 ohms; wiring diagrams of the pad are supplied with each of these controls.

An ordinary rheostat or potentiometer is not satisfactory for this purpose. As the resistance of a common control of this type is increased the mismatch between the output transformer and the voice coil also increases, resulting in severe sound distortion. The L or T pad holds the impedance match approximately constant between the output transformer and voice coil, regardless of the attenuation inserted in the circuit.



Hookup for the L- and T-pad circuit.

The control and switch of this device can be mounted in any suitable small container. The one shown (see photos) is a small, attractive, plastic flower pot, used in an inverted position. After the parts and cable are attached, the pot's water tray (saucer) is also turned upside down and cemented on what was originally the top of the pot. A piece of felt may be cemented to this new bottom to prevent scratching the furniture. This provides a handy mounting which can be set on a table or placed in the lap of the viewer. It does not upset easily because of its wide bottom.

A very light, flexible cable, 10 feet or more in length, connects the unit to the television receiver. When not in use it is coiled and hung on a hook screwed into the back of the TV cabinet. The gadget itself may be left hanging on the back of the TV receiver or set on top of the cabinet.

When the television set is turned on, the remote volume control is placed in the extreme clockwise position. With the knob in this position attenuation is minimum. The TV set volume control is adjusted so the sound is somewhat louder than desired. Further adjustments of sound level are then made from the viewing position. If desired, the sound may be cut off completely—without disturbing the volume level setting—with the on–off switch.

This little gadget could not be installed easily by persons unfamiliar with radio and TV circuits, but is simple for the experimenter to build and connect. It will provide great satisfaction to the constructor when distasteful babblings start pouring from his television loudspeaker. END

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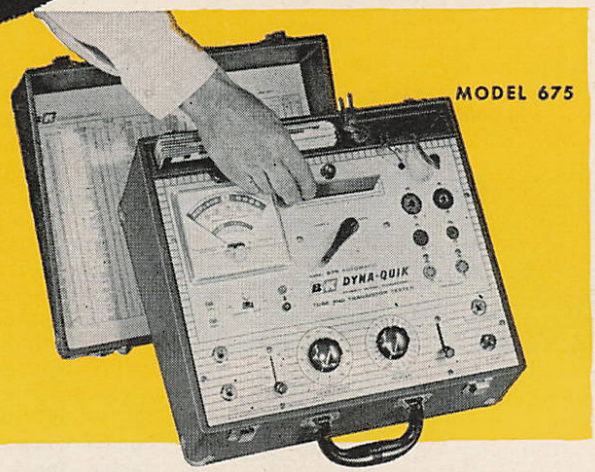

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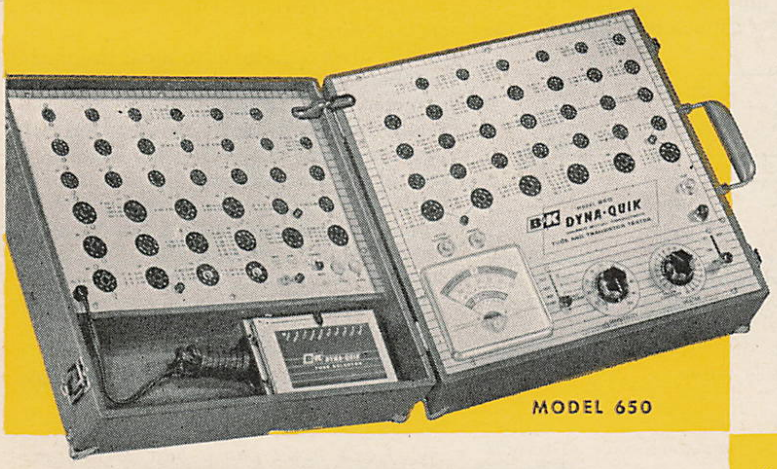

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COLOR TV receiver waveforms have frequency components ranging from 30 cycles to 3.58 mc or sometimes to 4.5 mc. For example, the chroma waveform shown in Fig. 1 has fundamental frequencies of 15,750 cycles and 3.58 mc.

To avoid distorting chroma waveforms, the scope attenuator must pass all waveform frequencies equally, at

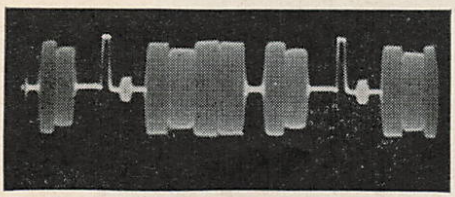

Fig. 1.—Typical chroma waveform has frequencies from 15,750 cycles to 3.58 mc.

any attenuator setting. This does not occur in old-style scopes nor in some of the low-priced modern ones.

Using a simple high-resistance potentiometer as an attenuator, as illustrated in Fig. 2, causes distortion. Stray capacitances C_{s1} and C_{s2} vary the high-frequency response as the attenuator arm is moved. This distorts a chroma waveform differently at each setting of the potentiometer.

To avoid frequency distortion in a simple potentiometer type attenuator, a low-resistance pot must be used—2,000 or 3,000 ohms. However, such a low input impedance loads down many receiver circuits and is undesirable.

For this reason a high-impedance attenuator which does not cause frequency distortion is used. It is arranged as in Fig. 3. A step configuration is used. When output is taken between R1 and R2, trimmer C is used to balance the effect of stray capacitance C_s. Accordingly, all frequencies in the

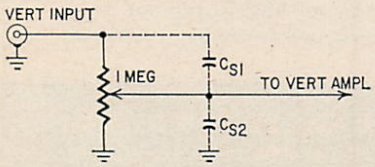

Fig. 2—A 1-megohm pot is a poor attenuator for a scope used in color-TV service. High-frequency response varies greatly at different attenuator settings.

waveform are passed equally to the vertical amplifier.

If C_s is very small, R2 must be shunted by a fixed capacitor (50 or 100 $\mu\mu$f) to bring trimmer C within range. This is a frequency-balanced system when the time constants R1C and R2C_s are made equal.

Most scopes provide several steps of input attenuation so a wide range of operating voltages can be tested without overloading the scope amplifier. For example, a simple step attenuator used in a typical wide-band scope is shown in Fig. 4. It has three decimal steps. Adjusting trimmer C1 balances the divider on the ×10 step. Trimmer C2 balances the divider on the ×100 step.

Trimmer capacitors in step attenuators are conveniently adjusted on the basis of high- and low-frequency square-wave patterns. They are adjusted for equal screen deflection at high and low frequencies, without ap-

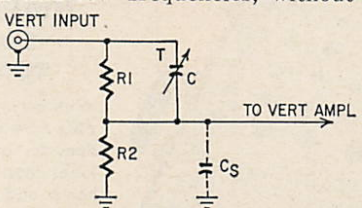

Fig. 3—A step divider can use high resistance, and causes no frequency distortion when trimmer C is correctly adjusted.

preciable tilt or curvature in a reproduced square wave.

Video puzzler

I have just repaired an Admiral 21Z1 with no sound or video. I found the tubes OK from the tuner to the picture detector. Then I suspected that there was a bad tube in the video circuit and also one in the sound circuit. The 6AC7 video amplifier was dead. Upon replacing it, both sound and video came in. Since sound takeoff is ahead of the picture detector, how could a dead video amplifier kill the sound? I find the same grid voltage on the sound if, with or without the 6AC7 in its socket. Can you figure this one out?—S. G., Elm Grove, W. Va.

This is a direct-coupled receiver, with no dc restorer. The agc keyer tube receives its supply voltages from a branch of the direct-coupled video amplifier circuit. Pulling the video amplifier tube changes the dc distribution. This changes the operating point of the keyer tube, and doubtlessly the change in agc bias makes the if amplifier inoperative. This accounts for the stoppage of sound when the 6AC7 is pulled.

Hot chassis

A Raytheon 2403A has a hot chassis, with frequent failure of the 25CD6 and 12AX4. What do you recommend?—O. B., Flint, Mich.

A Surgistor will limit the starting current of the series heater string and lengthen the tube life. The hot chassis can be "cooled" only by converting to a transformer power supply.

Color conversion

I would like to convert a Westinghouse model H840CK15 to use a newer picture tube, such as the 21AXP22. The 15GP22 in the set has gone gassy. Please advise me if this change is practical.—G. S., Waverly, Pa.

The 21AXP22 requires 5,000 volts more than the 15GP22 at the ultor. It also requires an electromagnetic convergence system. The electrical and mechanical changes required are so extensive that we cannot recommend this conversion. Perhaps you can convince your customer to trade this receiver in on a large-screen color set.

Decrease screen size

What 24-inch tube could be used instead of the 27-inch picture tube in a CBS Columbia receiver? Are any changes required?—A. L. R., Worcester, Mass.

It is always helpful to have the model number of the receiver. However, this is a conversion which appears practical, requiring mechanical changes only. If you are using a 27AP4, this is an electrostatic-focus tube, of the round metal type. It could be replaced with a 24DP4, which is also a 90° tube, but of glass construction. Both operate OK at 18 to 20 kv. The other 27-inch tubes are magnetically focused, and a suitable replacement would be a 24EP4, having an aluminized screen. Avoid the L type, which would require electrical changes.

70° to 90° conversion

A Fada 21C2 has a bad 21AP4 picture tube. I wish to replace it with a 21-inch 90° tube or a 24-inch tube. What circuit changes would be required

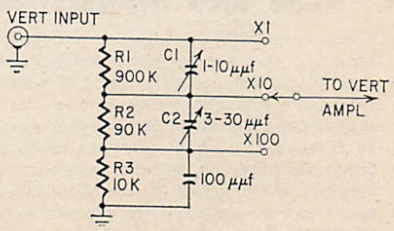

Fig. 4—A 3-step vertical attenuator as used in a typical wide-band scope for color-TV service.

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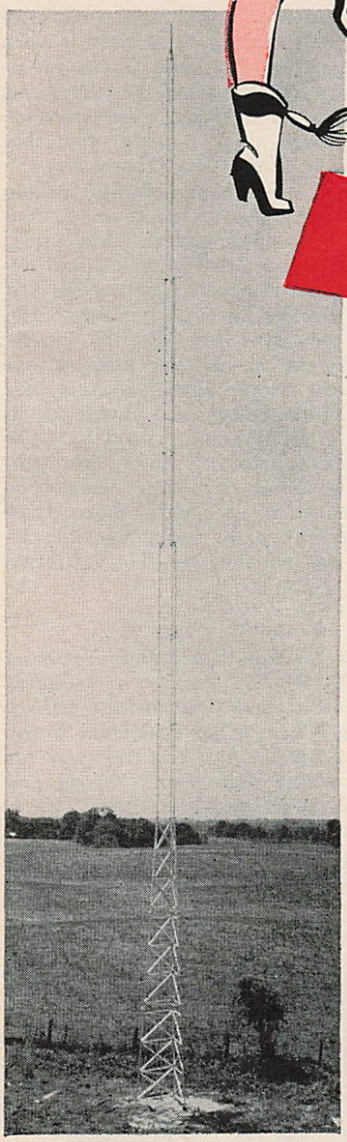

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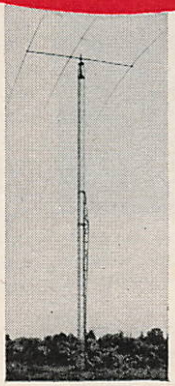

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for this replacement?—C. J. D., Brooklyn, N. Y.

We suggest that either a 21ACP4-A or a 21MP4 would be suitable. Both are 90° tubes. It cannot be definitely stated whether your present sweep circuit will fully scan these tubes. A little more sweep power may be required. If so, a 90° yoke and matching flyback must also be installed. However, it is worth trying the present sweep circuit before increasing the sweep power.

Unstable horizontal sweep

Since replacing the flyback in a Crosley S11-459 with a Ram X117, the horizontal sweep is unstable. The agc keying circuit is also inoperative. The video amplifier's plate voltage is 30% low, as is the 105-volt B-line. Removing the 6V6 audio output tube kills the picture. Any suggestions will be greatly appreciated.—G. W., Niagara Falls, Ont.

The keyer difficulty is probably due to incorrect polarity or voltage of the keying pulse, or possibly both. The

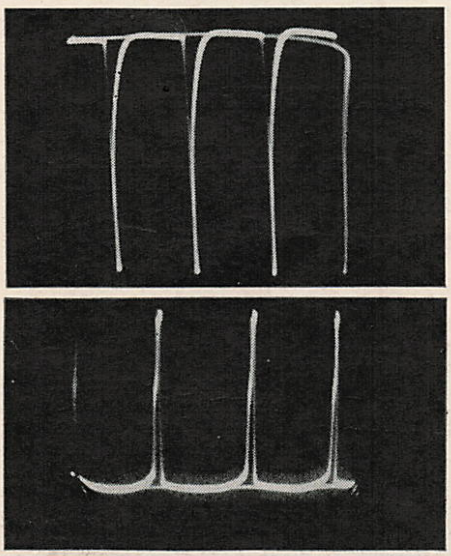


Fig. 5—Keyer pulses must have correct polarity and correct voltage: top—negative-going pulses; bottom — positive-going pulses.

pulses can be obtained in either positive or negative polarity, as shown in Fig. 5. This is best checked with a scope. Since the required keyer voltage is not stated in the service data, it would be helpful to check this against another receiver of the same type. Otherwise, it will be necessary to experiment with various keyer coils to obtain a pulse voltage in a suitable operating range.

To determine whether the horizontal sweep is unstable because of poor agc action, you can use override bias for a test. Removing the audio output tube kills the picture because the tube operates as a voltage divider in the B-supply system. Low plate voltage at the video amplifier is probably caused by operating the contrast control at its extreme position to compensate for the incorrect agc action.

Unavailable picture tube

I am working on a Van Aire 14S1 TV receiver which supposedly uses a 19BP4 picture tube. This type is unavailable, and I would like to determine some other usable tube type.—E. J. S., St. Louis, Mo.

You can use a 19AP4 in place of a 19BP4. Both are 60° tubes. No changes should be necessary.

27- to 21-inch screen

I am interested in converting a Muntz 2763A from a 27-inch to a 21-inch tube. Is this a practical change?—W. A. S., Dearborn, Mich.

We assume the problem is the cost of a replacement 27-inch tube. It is quite practical to go from the 27-inch tube to a 21. You could use either a 21AMP4 or a 21ALP4. A 21ALP4-B is somewhat more expensive, but has an aluminized screen which gives a higher contrast picture.

Needs flyback replacement

A Mirrortone A24C, chassis 9051, has a burned-out flyback transformer THC-10021. My local parts distributors are not able to supply a replacement. I will appreciate any help.—J. G., Racine, Wis.

The flyback originally used in this set was manufactured by Todd. No manufacturer to my knowledge makes a suitable replacement unit. The only alternative is to select some standard sweep circuit for the picture tube and rebuild the flyback section. We regret that no simple repair is possible.

AM on TV channels

An RCA 21-S-511N receiver is giving some trouble. It is in a home located three blocks from a local AM broadcast station. The AM signal is picked up on all channels. How can I remedy this situation?—E. A. S., Decorah, Iowa

First disconnect the lead-in. If the AM interference is still present, an rf filter must be installed at the receiver's power supply terminals. If this is insufficient, you may have to screen the interior of the cabinet and ground the screening. After any possible pickup by the line and chassis have been eliminated, reconnect the lead-in. If the interference is now evident, insert a high-pass filter at the tuner's antenna input.

In severe cases, two or three filters can be hooked in series for greater AM rejection. If the tuner input is substantially unbalanced, the lead-in will have a strong antenna effect. This can be eliminated by using shielded 300-ohm line from the antenna to the receiver. Finally, some antenna types are highly directive and can be beamed to minimize the field strength of the broadcast station.

Fuse-resistor blows

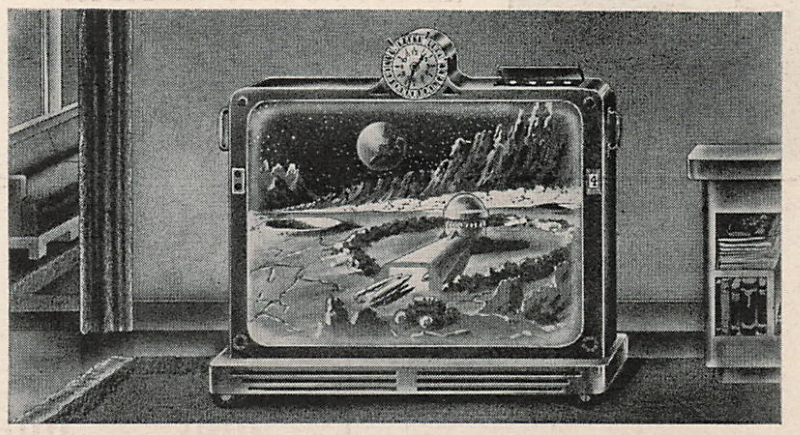
Recently I repaired a Zenith Z1817Z, chassis 15Z1, using a 6-ohm 5-watt fusible resistor. The fuse opens every few days. I have checked the filter, and B-plus voltages are OK. Can you suggest a cause and remedy for this trouble?—M. G. L., Greensboro, N. C.

The most usual cause of this trouble is a starting surge of current (caused by lower heater resistances when cold), inrush of current to the filters and decouplers, as well as the forming current required by the electrolytics when the set has been standing idle. Of course, there may be an elusive intermittent short in the power supply system, but the first thing to try is a Surgistor in the line. It is now being used by RCA (in another form) on their late production. A Surgistor is a relay type protector which prevents more than rated current being drawn until the receiver has warmed up. This requires about 10 seconds.

Tap the TV sound

I want to change the sound portion of an RCA 730TV1 from split sound to intercarrier. It will drive a high-fidelity amplifier. Where is the best place to tap the sound and the best circuit to use for least buzz and distortion? Thank you for this information.—L. B., New York, N. Y.

Intercarrier sound takeoff should be made from the picture detector output



How TV recorder-player described in editorial (page 33) might look while playing back a program. Clock in center top could be set to pick up a number of programs on desired channels, at specified times.

lead (input lead to the video amplifier). This avoids the possibility of intercarrier buzz if the video amplifier should tend to overload. We would advise the use of an intercarrier sound circuit similar to those found in color TV receivers. This will give you top performance. An example is the sound channel used in the Sentinel 816C.

Sound fades and blasts

We are having trouble with the audio in a DuMont Travis. It is all right for a few minutes or sometimes long periods, but then fades or gets very loud. We have checked the tubes and parts, but have not been able to locate the trouble.—W. L. McB., Wildrose, N. D.

This is a type of trouble best handled by either signal tracing or signal injection. You can use a scope to check stage by stage back from the speaker, to find out where the trouble first appears. In the higher-frequency circuits, a demodulator probe must be used instead of a low-capacitance probe.

Ion trap and brightness

In a Zenith 20J23, the ion-trap magnet has to be readjusted as the brightness control is turned up. Any help on this problem will be appreciated.—H. L. DeW., Tiffin, Ohio.

A 21-inch picture tube operates at high second-anode voltage and the first anode is easily eroded by misadjustment of the ion trap. Erosion causes distortion of the electron lens action in the picture tube. A new picture tube should clear up the difficulty. Be sure the ion trap is correctly adjusted as soon as the new picture tube is installed so the trouble does not recur.

Poor contrast

An Airline 05WG-3039B has very poor contrast. However, when the plate of the third if tube is touched, contrast improves to almost normal and remains good until the set is turned off and on again. I would appreciate any suggestions you can offer.—T. W. E. K., Hampton, Va.

This is very evidently a case of regeneration and border, line oscillation in the third if stage. Use a good sweep and marker generator and align the if strip carefully. However, if this trouble is caused by component failure alignment will not help and you should check the bypass and decoupling capacitors in the third if and detector stages for opens.

Needs if transformers

A Craftsman RC-200 with separate sound if's has come into the shop. The sound operates at 21.6 mc. I need replacement sound-if transformers. Can you suggest a source?—A. P., Portland, Ore.

We suggest the use of Miller 6190 and 6191 if transformers. Miller discriminator transformer 6192 matches these. You can obtain the units from any large parts jobber. END

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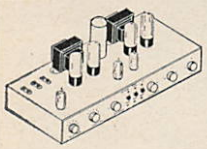

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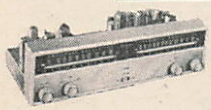

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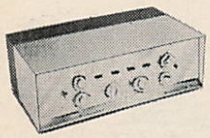

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TECHNICIANS' NEWS

INDUSTRY LEADERS MEET IN ANTI-FRAUD DRIVE

More heat than light was generated at an industry-wide meeting of 100 representatives of technicians' associations, TV manufacturers and distributors in New York City with State Attorney General Louis J. Lefkowitz to map measures to "eliminate fraudulent practices" in TV servicing.

Delegates at the stormy 2½-hour session agreed to nominate members for a seven-man committee to make recommendations for legislation and other state action to curb dishonest repairmen and tube counterfeiting. Several hot disputes developed over the quality of today's TV sets. Technicians' complaints centered around the use of printed circuits and the inaccessibility of chassis of some modern receivers.

The Attorney General said that complaints about TV repair and defective tubes constituted the second largest category of complaints sent to his office. Technicians told of their unsuccessful campaign for a state licensing bill. Lefkowitz called for a "bold solution" from the industry itself, perhaps in the form of a code of ethics or technicians' licensing law. The industry committee had not yet been appointed by press time.

Among those attending the meeting were representatives of the Empire State Federation of Electronic Technicians Associations (ESFETA), Association of Radio & Television Servicemen of New York (ARTSNY), Metropolitan Electrical Appliance Dealers Association, Electronic Industries Association (EIA), Tube Testers Association, Sylvania Electric Products Inc., RCA, New York City Better Business Bureau and several New York TV distributors.

The meeting was called shortly after the Attorney General obtained a court order against a Brooklyn TV repair shop accused of defrauding customers of more than $500,000 a year. A spokesman for the Attorney General said the shop, Benzack Stores Inc., advertised TV repairs at low prices as a come-on. When customers allowed their sets to be taken to the shop for an estimate, the shop would demand payment before returning the set. He said the company succeeded in appropriating about 1,000 sets from customers who couldn't pay the bill.

"CROOKS IN EVERY TRADE"

A Culver City, Calif., TV and service dealer won praise from his competitors and favorable comment from his customers with a newspaper ad designed to counteract "sensational newspaper stories regarding the crooked antics of a few racketeering service companies."

This was the caption of the quarter-page run by Milt Aller's Tops TV in Culver City, Venice and Mar Vista newspapers:

Newspaper Headlines!

'Banker Absconds With $500,000!'
'Doctor Accused of Illegalities'
'Lawyer Swindles Elderly Couple'
'TV Serviceman Bilks Public'

Yes, there are crooks in every trade and profession. Thank goodness, however, that these vipers represent only a tiny fraction of the millions of folks serving their fellow man and country with the highest ethics.

The ad went on to say that "there are crooks in every trade and profession" but they "represent only a tiny fraction of the millions of folks serving their fellowmen and country with the highest ethics." It warned against bait advertising, "ridiculously low prices" and "night riders."

The response to the ad led Aller to conclude that it may have served its purpose—as he put it—"to help clear the smog in the air and let John Q. Public know that he can get honest service if he calls a reliable company and is willing to pay a fair labor charge."

TRANSISTOR LECTURES

A series of eight lectures on transistors is being sponsored by Associated Radio and Television Servicemen (ARTS) of Chicago for members and guests. The twice-a-month sessions are conducted by speakers from CBS-Hytron, Zenith, Sylvania, RCA Service Co. and Motorola-Chicago.

NEW COMMITTEE FIGHTS CAPTIVE SERVICE

A national effort to battle the expansion of set manufacturers in the servicing field has been launched by a group of technicians' organizations under the banner of "Independent Dealers' Electronic Activities committee."

The new committee's initials—IDEA—represent its approach to the problem, declared Karl W. Heinzman, president of Television Service Association (TSA) of Michigan and a prime mover in the new group. He said IDEA intends to seek better communications between manufacturers and independent service dealers and to function as a spokesman in presenting the technicians' side of the picture "to the manufacturer, the public and the legislatures, both state and federal."

Heinzman said 22 state and local associations in 13 states have pledged their support to IDEA, which he

SENCORE FS-3 FUSE-SAFE METER

Time-Saver of the MONTH!

by Herb Bowden*

Cut down on costly call backs caused by blowing fuse resistors

Nearly all TV Manufacturers now produce TV receivers with fuse resistors in the power supply section. Technicians have learned that this component can be a real source of trouble unless the circuit is serviced properly. Many times, the fuse resistor is replaced and, apparently, the receiver is functioning normally. In a few days, the service technician makes an expensive call back, only to find the fuse resistor open again. The Sencore FS 3 Fuse-Safe meter is designed to test the power supply circuit to determine whether or not it is safe to replace the fuse resisitor. It can also be used in much the same manner to test circuits using fuses. It has a third function of serving as a wattmeter at 115 volts.

Fig. 3—Model FS 3 is designed to aid in checking fuse-resistor circuits.

WHY A FUSE RESISTOR IS USED

Let us see why a fuse resistor is used. The circuit shown in Fig 1 is a typical TV power supply as used in an Admiral 16AG1 portable. Fuse resistor R501 serves a dual purpose. It protects the selenium rectifiers from inrushing currents when the set is first turned on and at the same time, acts as a B-plus fuse. This lowers production cost, and, therefore, it is usually found in portable TV receivers and radios only.

HOW A FUSE RESISTOR IS DIFFERENT

The fuse resistor is unlike a fuse or conventional resistor to service. It is neither as stable as a heavy wire-wound resistor nor does it fuse like an ordinary fuse. For example, the AC current being drawn through the fuse resistor in figure 1 is approximately one ampere. This fuse resistor should not draw over 1.2 amperes and is usually operated below this level. If 1.5 amperes were drawn through the fuse resistor, it would open but perhaps not for days. If three amperes of current were drawn through the fuse resistor (which is approximately three times the rated amount), it would still take 60 seconds to open. Of course, the problem with the long delay when you have only a ten percent overload is that you are safely back at your service shop when the fuse resistor opens. This means another trip . . . no charge. The $8.95 cost of the FS 3 will soon pay for itself as these costly call-backs are prevented.

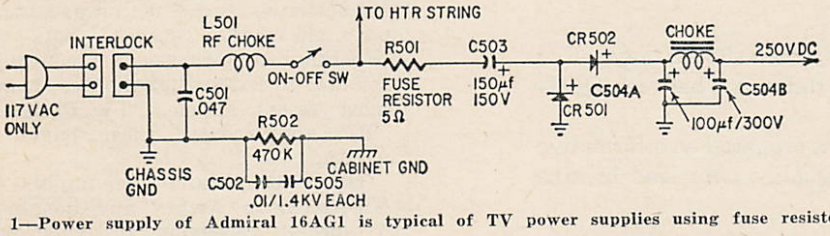


Fig. 1—Power supply of Admiral 16AG1 is typical of TV power supplies using fuse resistors.

WHAT CAUSES THE FUSE RESISTOR TO OPEN

A number of faults in the circuit shown in figure 1 will cause the fuse resistor to open. Here are some.

1. **Filter capacitors C503, C504A or C504B becoming leaky. The picture may appear normal but the fuse resistor will blow after several hours of continuous use.**
2. **Capacitors C504A or C504B increasing in capacitance. Current drawn through the fuse resistor is proportionate to the capacity value.**
3. **High AC line voltage.**
4. **Any B plus short in the receiver. This is one condition that may show up in the picture or sound before the fuse resistor blows.**
5. **A defective fuse resistor. Fuse resistors have been known to give a great deal of trouble under normal operating conditions, often when the circuit is operating properly. However, you can't be sure that it is only the fuse resistor unless the circuit is checked first.**

HOW TO TEST THE FUSE RESISTOR CIRCUIT WITH THE FS-3 CHECKER

The FS 3 Fuse Safe tester is especially designed to simplify the checking of fuse resistor circuits. Note that the FS 3 checks the operating current in the circuit and not the fuse resistor itself. The operating currents that pass through the fuse resistor are primarily AC, but can be mixed with DC and pulsating DC. The moving iron meter used in the FS 3 is constructed so that it will read either AC, DC, Pulsating DC or combinations of all three at the same time. To test the fuse resistor circuit, merely connect the test leads to the terminals that held the fuse resistor and read the meter. Be sure to remove the fuse resistor if it hasn't already burned out. Set the switches to the 2 AMP and TEST LEADS settings. A separate scale is used for each fuse resistor. See Figure 2. The scale is divided into a green area and a red area. If the reading is in the red area, there is more work to do to the circuit. If it is in the green area, it is safe to replace the fuse resistor. A 5 ohm, 10 watt resistor in built in the unit to protect the TV circuit during test time. The FS 3 can be left in the circuit at all times during repair, if the pointer is not pinned.

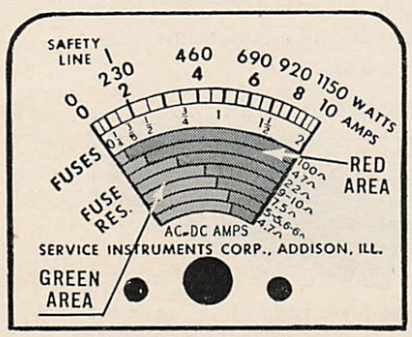


Fig. 2—FS 3 Meter Scale

OTHER FUSE SAFE CHECKS

The Fuse Safe meter can be used in the same manner as above for checking circuits with fuses to see whether or not it is safe to replace the fuse. A 2 ampere current scale for either AC or DC should be used for circuits that are normally used throughout the receiver, except for line fuses. If the meter indicates above the rating of the fuse, the circuits should be repaired or a higher value fuse used. This is especially handy in horizontal output circuits where the change of a damper tube, or the drive voltage on the output tube will lower the current and stop call backs on these intermittent fuse blowing sets.

To check line fuses or to use the FS 3 as a wattmeter, switch to PWR CORD and to the 10 ampere range. Plug in the line cord and then plug the unit into the AC receptical. Read either amperes or wattage directly from the two top scales.

WHY IT IS NECESSARY TO HAVE A SPECIAL METER TO CHECK THESE CIRCUITS

The FS 3 checker is the only service type tester available that will check the fuse resistor circuits accurately. This is because it is necessary to have a meter that will check AC, DC and pulsating DC at the same time. More than this, most service type meters do not read AC current at all. A DC Ammeter will read near zero in this curcuit. The most important reason for the use of the FS 3 is that it is the only meter that interprets the current rating of a fuse resistor for you. The TV schematics do not list the optimum ratings of the fuse resistors. They are not rated in power dissipation so that one can derive the operating current. More than this, there is little coordination between the physical size of the fuse resistor and the maximum current point. Here is a table of the maximum operating currents as determined by an investigation throughout the industry. The FS 3 red and green scales were determined from these values.

Fuse Resistor (ohms)	Maximum Operating AC (amps)
4.7	1.3
5	1.2
5.6	1.2
6	1.2
7.5	1.0
9	0.85
10	0.85
22	0.6
47	0.35
100	0.2

HOW TO DETERMINE VALUE OF FUSE RESISTOR TO USE IN THE RECEIVER

Most fuse resistors are marked with part numbers only. The schematic will generally show the value of the fuse resistor but is time consuming to look up and often is not available. If a fuse resistor burns out, merely connect the Fuse Safe checker in place of it and note the scale where the reading is about 10 per cent off the red area into the green. Install this value fuse resistor and it will protect the circuit and will not burn out due to overload. Naturally, the TV circuit should be operating properly before using the FS 3 for this check.

WHERE TO BUY THE FS-3

The FS 3 can be purchased from nearly every parts distributor in America and Canada. Just ask for the Sencore Fuse Safe that sells for $8.95 dealer net.

*President SENCORE
121 Official Road Addison, Ill.

—what is
the DIFFERENCE?

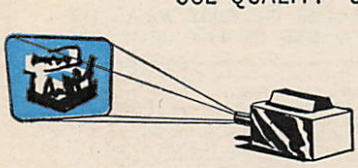
At a glance, all twin leads look alike. Why then should they sell at such widely different prices? What is the difference between Quality and "Price" twin leads?

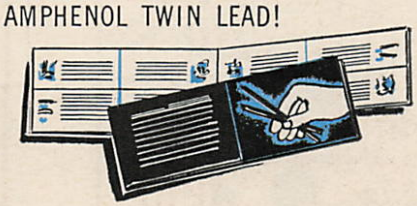
To answer this question, AMPHENOL has prepared an informative slide film. It compares "Price" versus Quality twin lead in nine important ways:

Quality Twin Lead	*vs*	*"Price" Twin Lead*
1. Virgin Polyethylene		1. Reclaimed, reground Polyethylene
2. Pure Polyethylene		2. Wax extenders
3. Exact mil thickness		3. Up to 10% less than marked
4. Strong copper conductors		4. Small strands, less copper
5. Properly annealed wire		5. Brittle, rejected wire
6. ¾" "lay" of wire		6. 1½" "lay"—less copper, less strength
7. Proper conductor spacing		7. Conductors close—wrong impedance
8. Full lengths on spools		8. Undership as much as 50 ft.
9. Quality manufacturing		9. Extrusion speedup, no inspection

Because of these differences, it's a gamble every time "Price" twin lead is used—a gamble that "saves" about 26¢ on a 50 foot installation! It's a gamble that the installer always loses.

USE QUALITY—USE AMPHENOL TWIN LEAD!





Arrange with your Authorized AMPHENOL *Distributor to see "What is the Difference?" get the facts on "Price" twin lead.*

Write for a copy of "What is the Difference?"—a useful booklet which summarizes the main points of the slide film.

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stressed is "a committee, not an association." He pictured the committee as a spokesman for the independent service dealer to gain him recognition as "an important small businessman," and provide him "a voice in the very things that affect his destiny."

Among the state technicians' associations represented by IDEA are TSA of Michigan, Texas Electronic Association (TEA), Television Electronic Service Association (TELSA) of Connecticut, Associated Radio & Television Servicemen (ARTS) of Illinois, Minnesota Television Service Engineers (TSE), the Electronic Association of Missouri (TEAM).

GE NAMES ALL-AMERICANS

Wayne E. Lemons, of A-1 TV & Radio, Buffalo, Mo., was one of 10 service technicians winning General Electric's 1958 All-American Awards for public service. He was selected for

his activities in conducting extracurricular electronics courses, youth work and other civic causes. A frequent contributor to RADIO-ELECTRONICS, Lemons' most recent article, "TV Design for '59," appeared in these pages last month.

Other technicians receiving the $500 All-American Award and honored at a special ceremony in Washington, were: Stanley Everett, Everett's Television & Radio Sales, Alhambra, Calif.; A. George Catavolo, Elm Radio & TV Service, Somerville, Mass.; Albert P. Kazukonis, Brockton Television, Brockton, Mass.; Edwin B. Haines, Oxboro Radio & TV, Bloomington, Minn.; Vernon E. Brooks, Brooks Electric Co., Norristown, Pa.; Theodore W. Fickert, Hoover's Radio–TV, Lansdale, Pa.; T. E. (Buck) Adams, Adams Appliance & Hardware, Channing, Tex.; Bryce R. McNeely, McNeely's Ace TV, Longview, Wash.; Vernon Townsend, Townsend's Radio & Lock Service, Menomonie, Wis.

HARMON HEADS TESA–OHIO

Russ Harmon of Cincinnati was elected president of the Television & Electronic Service Association (TESA) of Ohio at the convention in Springfield. Don Sisk, Columbus, was chosen first vice president; V. H. Bailey, Dayton, second vice president; John P. Graham, Columbus, secretary, and Marvin Miller, Springfield, treasurer.

Jack Barton of TSA–Detroit spoke on the effectiveness of that city's Technician licensing ordinance. John Graham and Don Wilson reported on a

proposed license law for Columbus. Other problems discussed were captive service and elimination of unethical practices in servicing. Toledo was selected for the spring convention.

PART-TIMERS SURVEYED

The increasing activity of part-time service technicians is under close scrutiny by the Television & Electronic Service Association (TESA–MARTS) of Milwaukee. A recent survey of members revealed that they considered "the wrong kind of part-timers" their biggest problem.

The TESA–MARTS part-timer campaign is aimed at spotlighting those who compete unfairly with law-abiding technicians. Using names of part-timers supplied by members, the association plans to determine through city, state and federal governments whether part-timers are paying their income taxes, keeping adequate books, complying with zoning ordinances, paying commercial telephone rates and making proper declaration on their city personal property tax forms. All discrepancies will be reported to the Better Business Bureau.

FREE SERVICE DROPPED

Independent service technicians won a partial victory when a large California radio and television manufacturer agreed to drop a program of servicing all brands of radios and advertising "free service" on its own-make sets.

Following protests by technicians' associations, president Robert S. Bell of Packard-Bell Electronics announced that the plan was a 2-week "experiment" and that "we will no longer advertise or service radios free of charge—nor will we service other brands of radios."

TV SHOW PLUGS SERVICE

Organized TV technicians in particular, and the independent service industry in general, is receiving a big boost on a filmed TV show now in national release.

The *Paul Coates Show*, which originates at KTTV, Los Angeles, and is syndicated to other stations in filmed form, devoted one episode to TV service. A reformed "crooked TV technician," was interviewed on the tricks dishonest shops employ. Then Lee Neal, of the Burbank Chapter of Society of Radio & Television Technicians (SRTT), answered questions, urging that set owners choose a technician who is a member of an association and warning against supermarket tube checkers.

The idea was suggested to Coates by SRTT member Ralph Johonnut of Tri Color TV, Burbank, while servicing Coates' set. Coates liked it, and the show was arranged, unrehearsed. It had one immediate result in the Los Angeles area: The Better Business Bureau opened an investigation of supermarket tube checkers. END

IMPORTANT NEW BOOKS

FUNDAMENTALS OF TRANSISTORS (2nd edition) *by Leonard M. Krugman, P.E.* This, the second edition, (revised and expanded) modernizes the highly successful and popular first edition, so as to embrace the latest developments in the transistor art. #160, **$3.50.**

A-C CIRCUIT ANALYSIS (Electronic Technology Series) *edited by Alexander Schure, Ph.D.* Fundamental concepts of alternating current made completely understandable. Comprehensive mathematical treatment. #166-19, **$1.80.**

CONDUCTANCE DESIGN OF ACTIVE CIRCUITS *by Keats A. Pullen, Jr., Eng.D.* The non-linearity of electron tubes and transistors has for many years greatly complicated the design of active circuits associated with these devices. This book presents a proven method of overcoming these complications. It presents the conductance technique as applied to the design of a wide variety of vacuum tube and transistor amplifier, mixer and oscillator circuitry, in the broadest sense. #207, Cloth Bound, **$9.95.**

BASIC PULSES *by Irving Gottlieb, P.E.* Pulses are vital in every area of electronics-computer, radar, industrial, television. This 'picture-book' course covers the nature, measurement and application of pulses—what they are and how they are used. #216, **$3.50.**

VACUUM TUBE CHARACTERISTICS (Electronic Technology Series) *edited by Alexander Schure, Ph.D.* Provides an extremely comprehensive discussion on vacuum tubes, their constants and characteristics making the fundamentals of vacuum tubes fully understandable. #166-22, **$1.80.**

HOW TO TROUBLESHOOT A TV RECEIVER (2nd edition) *by J. Richard Johnson.* The second edition of this highly popular book has been expanded and brought up-to-date. Shows how to pinpoint troubles in all types of TV receivers and how to repair them quickly. #152, **$2.50.**

METALLIC RECTIFIERS & CRYSTAL DIODES *by Theodore Conti.* Covers background, construction, characteristics and applications of crystal diodes and metallic rectifiers. #213, **$2.95.**

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NEW TUBES and SEMI-CONDUCTORS

A VARIETY of types appear this month. Highlights are a 110° extra short picture tube, a power transistor for TV deflection circuits, an ultra-high-speed switching transistor, and a duo-diode-tetrode for auto radios.

2N1046

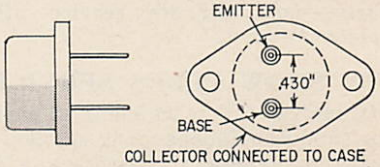
A p-n-p diffused junction high-frequency power transistor designed for horizontal and vertical CRT deflection circuits. It has a hermetically sealed, welded metal case with glass-to-metal seals between the mounting base and the leads.

Maximum tentative ratings of this Texas Instruments transistor at 25°C are:

V_{CBO}	80	(I_C=2 ma)
V_{CE}	80	(V_{BE}=0.2, I_C=2 ma)
V_{EBO}	1	(I_E=2 ma)
I_C (amps)	3	
P_{total} (watts)	15	

Design characteristics at 25°C are:

f_T (mc)	10	(I_C=0.2 A, V_C=20)
h_{FE}	70	(I_C=0.5 A, V_C=2)
C_{ob} ($\mu\mu$f)	140	(I_E=0, V_{CB}=40)



2N1021 & 2N1022 & 2N1046

2N1021, 2N1022

Germanium p-n-p alloy-junction power transistors designed for high-voltage power converters, amplifiers and switching circuits. They feature low distortion, linear transconductance, low saturation resistance and fast switching times.

Maximum ratings of these Texas Instruments units at 25°C are:

	2N1021	2N1022
C_{CB} (I_C = 2 ma)	100	120
V_{CE} (V_{BE} = 0.2, I_C = 2 ma)	100	120
V_{EB} (I_E=2 ma)	30	30
P_{total} (mw)	50	50
I_C (amps)	5	5
I_B (amps)	3	3

2N307-A

This p-n-p power transistor is intended for general-purpose applications, particularly for audio-frequency circuits.

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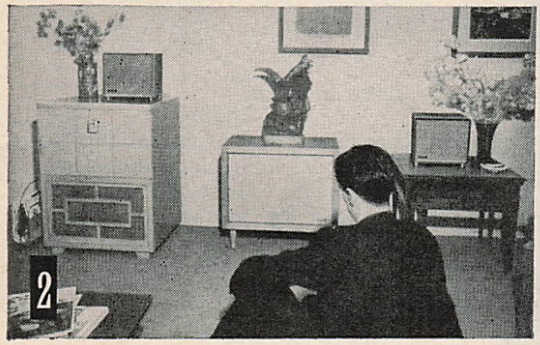

University® offers four ways to stereo

1 ***Leading Metropolitan Opera Star Leonard Warren converted to stereo quickly, easily and inexpensively... using a compact Stereoflex-2* "add-on" speaker with his University "Troubadour"***

This approach solves many problems for those already possessing a full-range monophonic system, as well as those planning to buy one now with an eye to stereo later. Thanks to the *exclusive dual voice coil* woofer used in all University stereo-adapted systems, only one such woofer is needed to reproduce the *combined* bass below 150 cycles† of both stereo channels. Thus all three models of University "add-on" speakers provide a perfect match by *direct* connection to the original speaker system. Stereoflex-1* is well suited for bookshelf installations. Stereoflex-2, with its narrow silhouette, makes a fine end table. Model SLC* can be affixed to a wall or "lite-pole," its decorative fibreglas housing blending smartly with modern furnishings. Each can also be used with any brand monophonic system *not* having a dual voice coil woofer, by using a University Stereo Adapter Network Model A-1.

2 ***Discriminating music lovers may also enjoy magnificent stereo by simply connecting two University "add-on" stereo speakers to a single dual voice coil woofer* in a suitable enclosure***

This approach offers great versatility. Since the woofer's position in the room is uncritical for stereo†, it may be installed wherever most convenient . . . in a small suitable enclosure, or in a wall, closet, etc. The two "add-on" speakers can then be placed to provide optimum stereo reproduction, without upsetting existing room decor.

3 ***Noted maestro Fred Waring chose a pair of University RRL* Ultra Linear Response speakers for his stereo system***

When planning his recent cross country concert tour, *Hi Fi Holiday*, Fred Waring turned to University engineers for a compact, quality high fidelity speaker system that could overcome the acoustical deficiencies of the theatres and auditoriums in which The Pennsylvanians would be playing. The performance of the S-11 Ultra Linear Response speakers, mainstays for the system, proved so outstanding that Mr. Waring chose two of them for his own home. Two such identical speakers are an excellent stereo solution in rooms where they can be placed in reasonably symmetrical positions. All University systems are ideally suited for this purpose, because they are stereo-matched in production to within 1 db.

4 ***Internationally famed violinist Mischa Elman prefers his stereo all-in-one . . . he selected the fabulous TMS-2*, 'Trimensional' stereo speaker that in his words . . . "approaches the authenticity of concert hall performance."***

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†Bass frequencies below 150 cycles do not contribute to the stereo effect.

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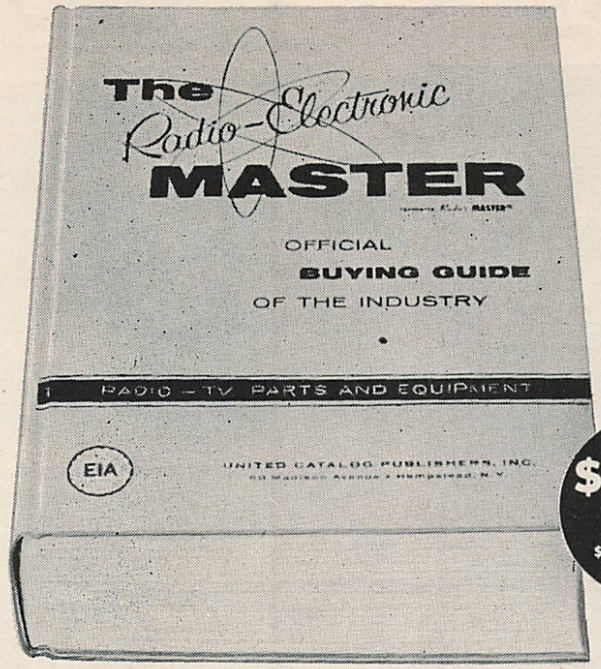

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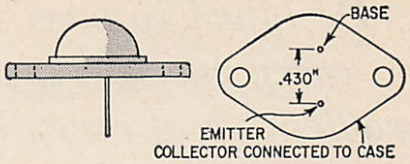


2N307-A

Maximum ratings for the Sylvania 2N307-A at 25°C are:

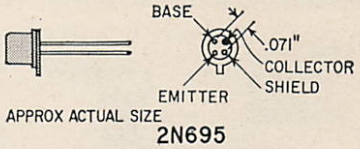
V_{CB}	35	
V_{CE}	35	(R_{BE}=30 ohms or less)
I_C (amps)	2	

Characteristics at 25°C are:

h_{FE} (min)	20	(V_{CE}=1.5, I_C=0.2 A)
f_{ae} (min) (kc)	3.5	(V_{CC}=14, I_C=0.5 A)
P_g (typ) (db)	27	

2N695

This Mesa type germanium p-n-p diffused-junction transistor is designed primarily for reliable operation in ultra-high-speed switching applications. The small size of junctions and internal



2N695

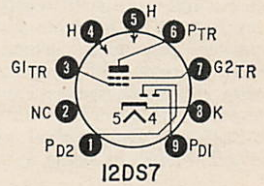
leads required for uhf operation results in a serious limitation on allowable surge currents. These transistors will be damaged by voltage and current surges when plugged into live circuits.

Maximum ratings of this Motorola unit are:

V_{CB}	15
V_{CE}	12
V_{EB}	3
I_C (ma)	20
P_c (mw)	50
(derate 1 mw/°C above 50°	

12DS7

The 12DS7 is a multi-unit tube of the nine-pin miniature type. It has two diodes and a high-perveance power tetrode in its envelope. It is intended



12DS7

for use in hybrid auto radio receivers where tube and transistor electrode voltages are taken directly from the 12-volt storage battery. In such receivers, the diodes are used for AM signal detection and the tetrode serves as a driver for the transistor af power output stage. The unit is made by RCA.

Typical operating characteristics of the tetrode unit in audio driver service are:

V_P supply	12.6	
V_P	12.6	(obtained from plate supply through series 100-henry choke with 150-ohm dc resistance)
V_{g1} supply	12.6	
V_{G2} supply	12.6	
R_{G2} (megohms)	1.8	
R_K (ohms)	18	
I_P (ma) (0 sig)	23	
(Max sig)	13	

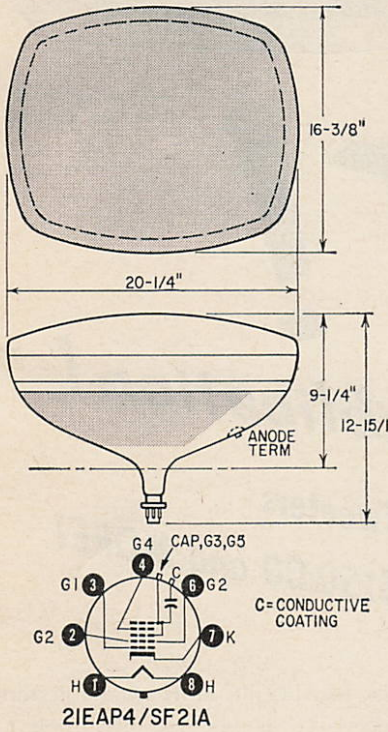
I_{G1} (ma)	77
R_L (k ohms)	1.25
Total harmonic distortion (%)	8
Max sig out power (mw)	10

Maximum ratings of the diode sections are:

I_P (ma)	5
$V_{htr-cath}$ (peak)	16

21EAP4/SF21A

An extremely short electrostatic focus and magnetic deflection, direct-view rectangular picture tube for television receivers. Overall length is only 12 15/16 inches. The heater is rated at 600 ma, 2.34 volts with controlled warmup for



series-string circuits. Metal-backed screen, straight gun requiring no ion-trap magnet, external conductive coating and glass button base are featured.

Maximum ratings of this Philco Semi-Flat picture tube in grid-drive service are *(voltages positive with respect to cathode unless indicated otherwise)*:

V_{anode}	20,000
V_{g4}	—700 to 950
V_{g2}	550
V_{g1} (neg bias value)	155
(neg peak value)	250
(pos bias value)	0
(pos peak value)	2
$V_{heater-cathode}$	
(htr neg respect to cath)	
(during 15 sec warmup)	450
(after warmup)	200
(htr pos respect to cath)	200

Miscellaneous

Four alloy-junction transistors for airborne, missile and other military applications have been announced by Sperry. They are the 2N1024, 2N1025, 2N1026 and 2N1027.

A group of 10-watt diffused silicon power regulators have been introduced by Texas Instruments. They come in 5% and 10% tolerances and in ratings from 22–91 volts. END

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- ✓ Checks for gas content.
- ✓ Checks for life-expectancy.

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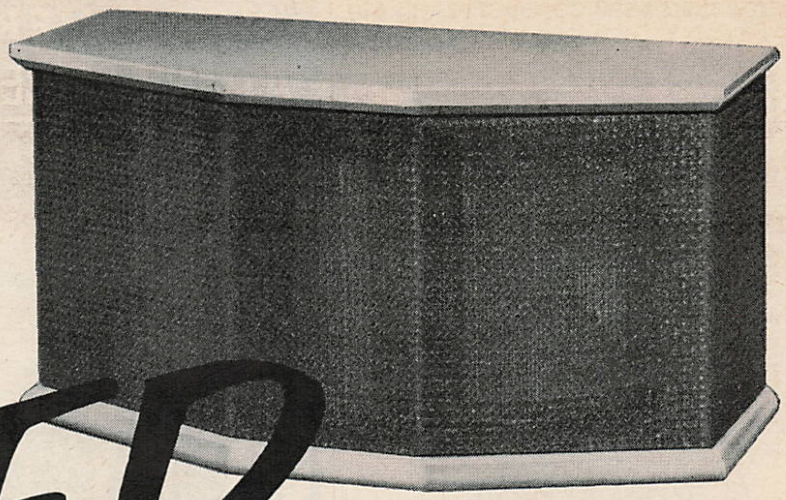

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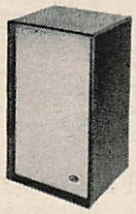

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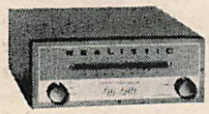

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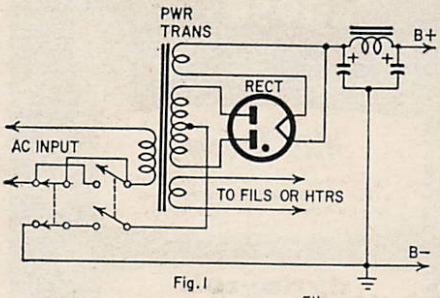

Fig. 1

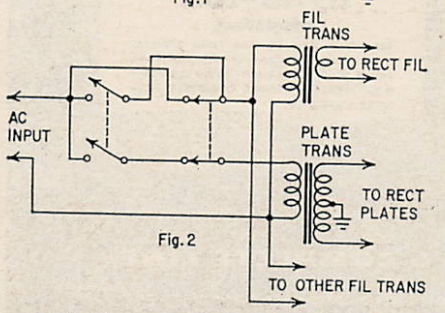

Fig. 2

can't do it any other way. No matter which switch you turn on first, the filaments go on. And no matter which switch is turned off first, it turns off the B plus. Fig. 1 is for supplies with a single power transformer and Fig. 2 for separate plate and filament supplies. You can stop worrying about hitting the wrong switch first and losing an 83 or a couple of 866's.—*Leslie Davis*

THE DOT MAKER

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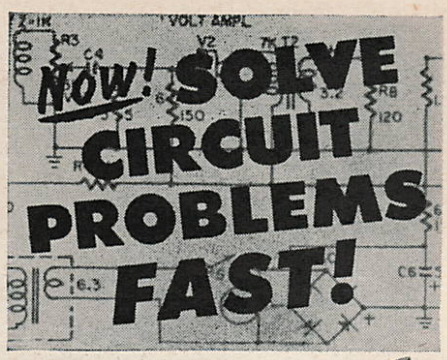
As a result the Dot Maker was developed. It is extremely simple to construct and all parts are readily available. Two G-E 2N107 p-n-p transistors are used. The first (V1) is a blocking oscillator having a repetition rate of from 1 to about 40 pulses per second. Referring to the diagram, the combination of R1, R2 and C1 establishes the pulsing frequency. Potentiom-



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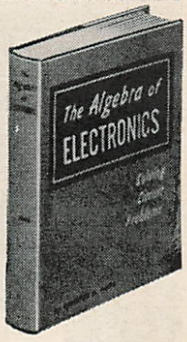

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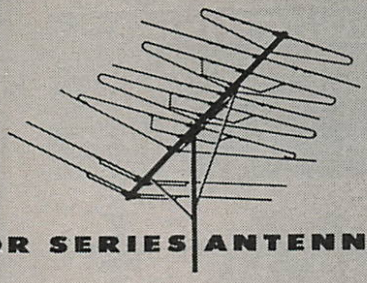

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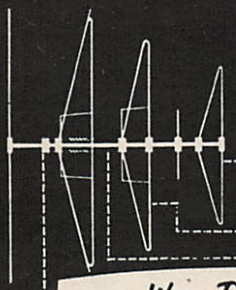

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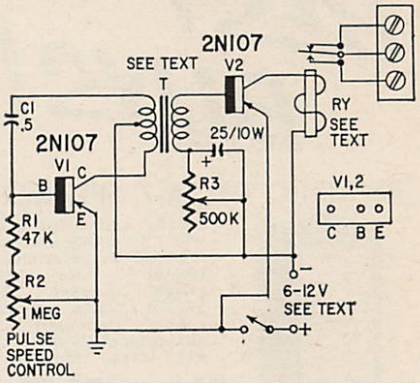
eter R2 is the actual speed control and this is mounted on the front panel along with the on–off switch.

Transformer T can be almost any audio transformer designed for plate-to-push-pull grids. In the original model a Stancor A-53-C was used, although specially designed transistor transformers such as the Argonne AR-102 work equally as well. The second stage



using a 2N107 transistor is an amplifier and is used to increase the pulsating current to a value suitable for relay operation. Resistor R3 in the base circuit of the amplifier controls the actual current flowing through the relay. As the 2N107 can operate with 5-ma collector current, any radio-control or plate-circuit type relay having a coil resistance of up to 10,000 ohms and operating on a current of less than 5 ma could be used. The relay in actual use is a surplus unit which came out of a Beacon receiver. It has a coil resistance of 10,000 ohms and operates on only 0.4 ma! Another relay that has been used in this unit is an Advance plate-circuit type having a coil resistance of 2,500 ohms and an operating current of 2 ma. As the 2N107 collector current kicks downward on each pulse, use a spdt relay so that each pulse can either make or break an external circuit. For powering the Dot Maker any battery voltage between 6 and 12 volts may be used, depending upon the relay.

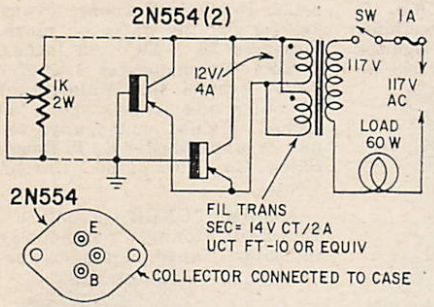
To operate the Dot Maker set potentiometer R2, the speed control, to approximately mid-range. Turn on the power switch and adjust potentiometer R3 until the relay starts operating with each pulse. A 5-ma meter can be connected between the bottom of the relay and the battery's negative terminal to check relay or collector current. Always use the amount of relay current needed for reliable relay operation, *but don't exceed 5 ma.* There is nothing critical about wiring and, as long as the circuit is wired correctly, it should work. Sometimes, reversing the relay leads will give smoother operation. It may also be necessary to reverse the transformer's secondary leads for improved operation.

Since building the Dot Maker, several other applications have come to mind. As mentioned before, it could be used to key a transmitter carrier, or the clicking of the relay may be used to modulate a phone transmitter. The relay could also key an audio oscillator

which, in turn, may be used for modulation purposes. It might also be used to flash lights in a display or it may serve as a metronome. More uses will soon become apparent to the builder. —*Mitchel Katz, W2KPE*

TRANSISTOR POWER CONTROL

This circuit controls power loads over a wide range from an input resistor rated at 2 watts or less. In effect, the input resistance is amplified by the transistor's current gain, nominally 50,



so that 2 watts dissipation in the input results in 100 watts on the load.

Small motors—sewing machine, mixers, small tools, appliances — are smoothly controlled. The system is applicable to remote control since very light connecting wires may be used. In some cases a single wire with ground return is effective.

In designing for higher powers, more 2N554's may be paralleled and heavier transformers used. Estimate transistor current at about 3 amps per unit on the 12-volt side. Transistors should be mounted on an aluminum chassis or other heat sink.—*Motorola Semiconductors*

END

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Some larger libraries still have copies of Modern Electrics on file for interested readers.

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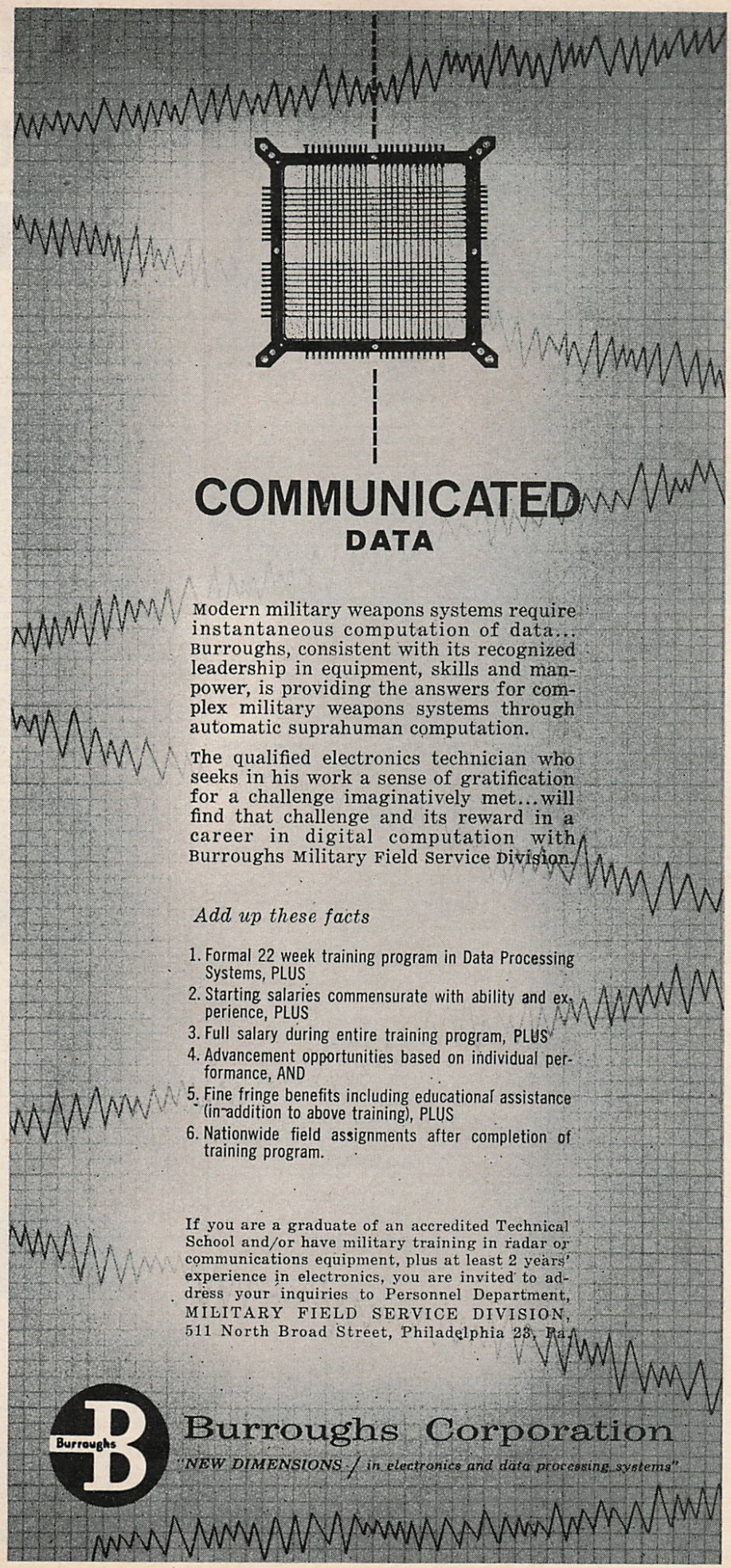
Carborundum, by Lewis W. Klopper.
Modern Wireless Instruments.
Thermoelectric Detectors.
Walking Wireless Station.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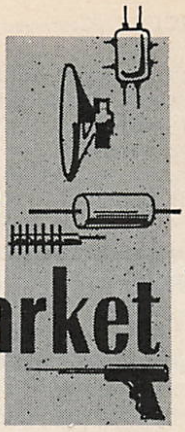
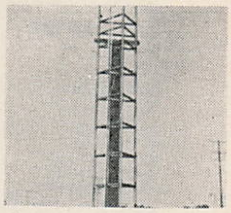


CRANK-UP TOWERS, *H series.* Available in 3 sections. No guy wires needed. 14-gauge tubular aircraft steel, 4,200-lb-

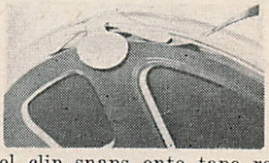


test aircraft cable. To 400 feet. Hot-dipped galvanized finish or enamel. 12- and 18-inch triangular construction. 1-inch tubing. —**Tele-Vue Towers Inc.,** 701 49 St. S., St. Petersburg, Fla.

TAPE RECORDER, *model 250.* 3-speed (1⅞, 3¾ and 7½ ips). Pushbutton controls. Solenoid-actuated automatic shut-off stops machine at end of reel and returns controls to neutral position. Dual-cone 6-

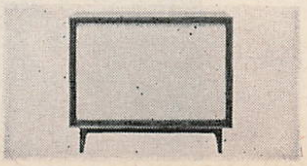
inch speaker with 3½-inch tweeter. Distortion less than 2%. Frequency response 50–15,000 cycles. Output jacks for external speakers and amplifiers. High- and low-level inputs. Digital counter. Record-level indicator.—**Telectrosonic Corp.,** 35-18 37 St., Long Island City 1, N. Y.

TAPE CLIP, *Reel-Neat.* Ends tape spilling. Polished stainless



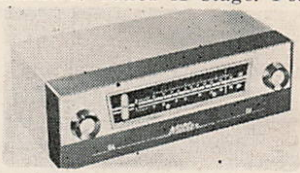
steel clip snaps onto tape reel, keeping it neatly wound.—**Toyco Products,** Audio Div., 1712 W. Florence Ave., Los Angeles 47, Calif.

SPEAKER ENCLOSURES, *Urban B-305* (shown) and *B-302A.* Modern design. Infinite



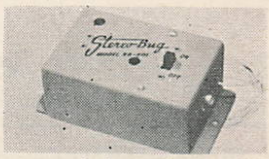
baffle. B-305 is 2-woofer 3-way system for 30 watts or more, measures 36 x 20 x 30 inches. B-302A accommodates 1-woofer 3-way system for minimum of 20 watts and is 24 x 20 x 30 inches. Walnut, mahogany, ebony or unfinished.—**R. T. Bozak Sales Co.,** Box 1166, Darien, Conn.

AM–FM TUNER, *Model 561.* Flywheel tuning. Feather-ray indicator. Tuned rf stage. Fos-



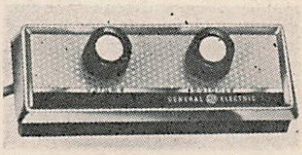
ter-Seely discriminator. Multiplex jack. Built-in antenna. Sensitivity 2 μv for 20-db quieting on FM. 30 μv for 20-db signal-to-noise ratio on AM. Frequency response 20–20,000 cycles on FM, 20–7,500 on AM. —**J. W. Miller Co.,** 5917 S. Main St., Los Angeles 3, Calif.

PHONO OSCILLATOR, *Stereo Bug model SB-201* adds second channel to any record player for stereo discs. Wireless system uses any broadcast-band radio



as second-channel amplifier–speaker. Battery-operated. Ceramic stereo cartridge required. —**Stereo-Ette Co.,** 4908 N. Lincoln Ave., Chicago 25, Ill.

STEREO REMOTE CONTROL, *model RG-1000.* Sets channel balance and volume from as far as 30 feet from amplifier. Dual plugs fit in amplifier's tape output jacks. May also be used as volume control



with monophonic amplifier and as volume-balance control with pair of monophonic amplifiers. —**General Electric Co.,** Specialty Electronic Components Dept., W. Genessee St., Auburn, N. Y.

WALL-MOUNTED STEREO. *Music Wall* cabinets, available separately or as matching complete stereo system, house *DB 212* stereo dual 12-watt preamp–amplifier and stereo phono in

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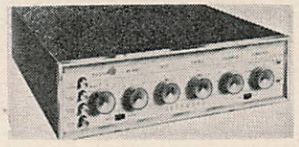
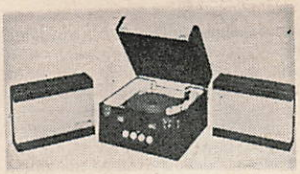
witch turns off entire system after last record has played. Balance control, reverse switch, dual microphone inputs for stereo recording plus low-impedance and dual tape outputs for tape recording. Stereo or mono operation through both speaker systems. Fletcher-Munson compensation. 6 inputs. Cathode-follower tape output. Frequency response ±1 db 20 to 20,000 cycles. Harmonic distortion less than 1%, IM less than 1.5% at full output. 11 tubes plus rectifier.—**Pilot Radio Corp.**, 37-50 36 St., Long Island City 1, N. Y.

STEREO AMPLIFIER, *model S-5000.* Dual 20-watt amplifier and preamp with complete control facilities. Reverse and phase-inversion switches. Monaural operation uses both chan-



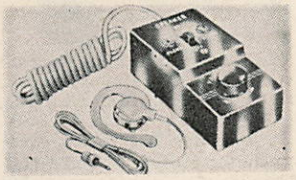
nels. Response 20–20,000 cycles ±½ db at 20 watts. IM distortion 1½% at full power. Cathode-follower recording outputs. 11 tubes plus selenium rectifier. —**Sherwood Electronic Labs Inc.**, 4300 N. California Ave., Chicago 18, Ill.

STEREO PHONO, *Trixtereo* portable, manufactured by Trix Electrical Co. of London. Record player with 2 matched full-



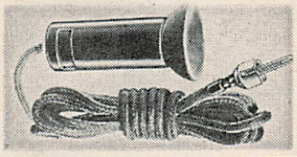
range speakers in separate detachable enclosures. Double-channel 8-watt amplifier. Garrard stereo cartridge.—**Ercona Corp.**, Electronic Div., 16 W. 46 St., New York 36, N. Y.

REMOTE VOLUME CONTROL easily attached to TV or radio receiver for devotees of



late night listening and for the hard of hearing. Earphone, 2 phone jacks, volume control, 20 feet of cable.—**Argonne Electronics Mfg. Co.**, 165-11 South Rd., Jamaica 11, N. Y.

TELEPHONE PICKUP, *model M-133.* Detects both sides of telephone conversation for use in



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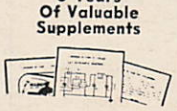

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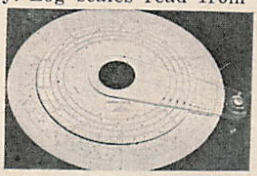
tape recording or for amplification (by any amplifier with magnetic input). Suction cup holds pickup firmly to receiver. 6-foot shielded lead with phono plug. ⅝ inch in diameter, 2 inches long.—**Olson Radio Warehouse,** 260 S. Forge St., Akron, Ohio.

CIRCULAR SLIDE RULE, *Dial-O-Matic.* Adds and subtracts scale lengths automatically. Log scales read from 10^{10}



to 10^{-10} with adjacent reciprocal scales. Face of rule carries L, K, A, DI, D, C, LL_1, LL_2, LL_3 and LL_4; back carries T, ST, S, D, SH and TH scales. Cursor – rotor – stator cooperation simplifies calculation. — **Eckel Co.,** 31 St. Joseph St., Arcadia, Calif.

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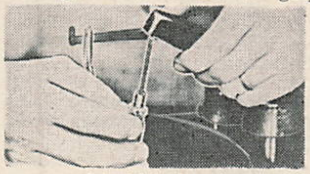
jobs. Lightweight, scientifically balanced. — **Weller Electric Corp.,** 601 Stone's Crossing Rd., Easton, Pa.

CARTRIDGE TOOL, *G-C Mini-Hold.* Specially designed screwdriver for replacing phono cartridges has device to grip



screw and hold it in place while shaft turns it out. *No. 9346* (3¼ inches long) in use reduces in size to 2⅞ inches. *No. 9347* reduces from 7 to 6¾ inches.—**General Cement Mfg. Co.,** 400 S. Wyman St., Rockford, Ill.

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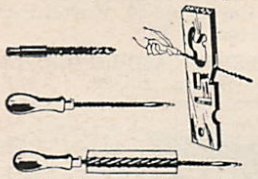

in wood, plaster, plywood, plastic or masonite. Available as hand tools—*Drillsaws* and *File Rasps*—and as *Drill Routers* to fit ¼-inch chuck for hand drills and drill presses.—**Walsco Electronics Mfg. Co.,** 100 W. Green St., Rockford, Ill.

DISPLAY PANEL LIGHT, *Transelec Echo-Lite.* Combines

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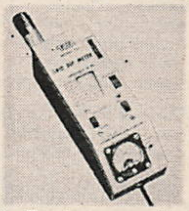

in 0.5%. Tuning capacitor planetary drive with 1:7 ratio. Drum rotates 340°. 117 volts ac.—**Electronic Instrument Co.,** 33-00 Northern Blvd., Long Island City 1, N. Y.

TRANSISTOR TESTER, *model 690-A.* Positive leakage and gain tests for p-n-p and n-p-n types. Measures dc beta from 5 to infinity. Exact test for shorts and leakage, forward and reverse leakage of diodes. Separate "calibrate" and "gain" buttons. Single-switch selection

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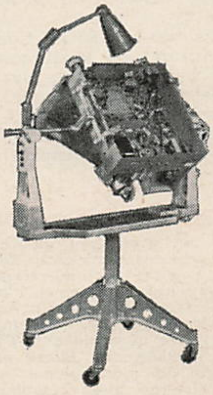

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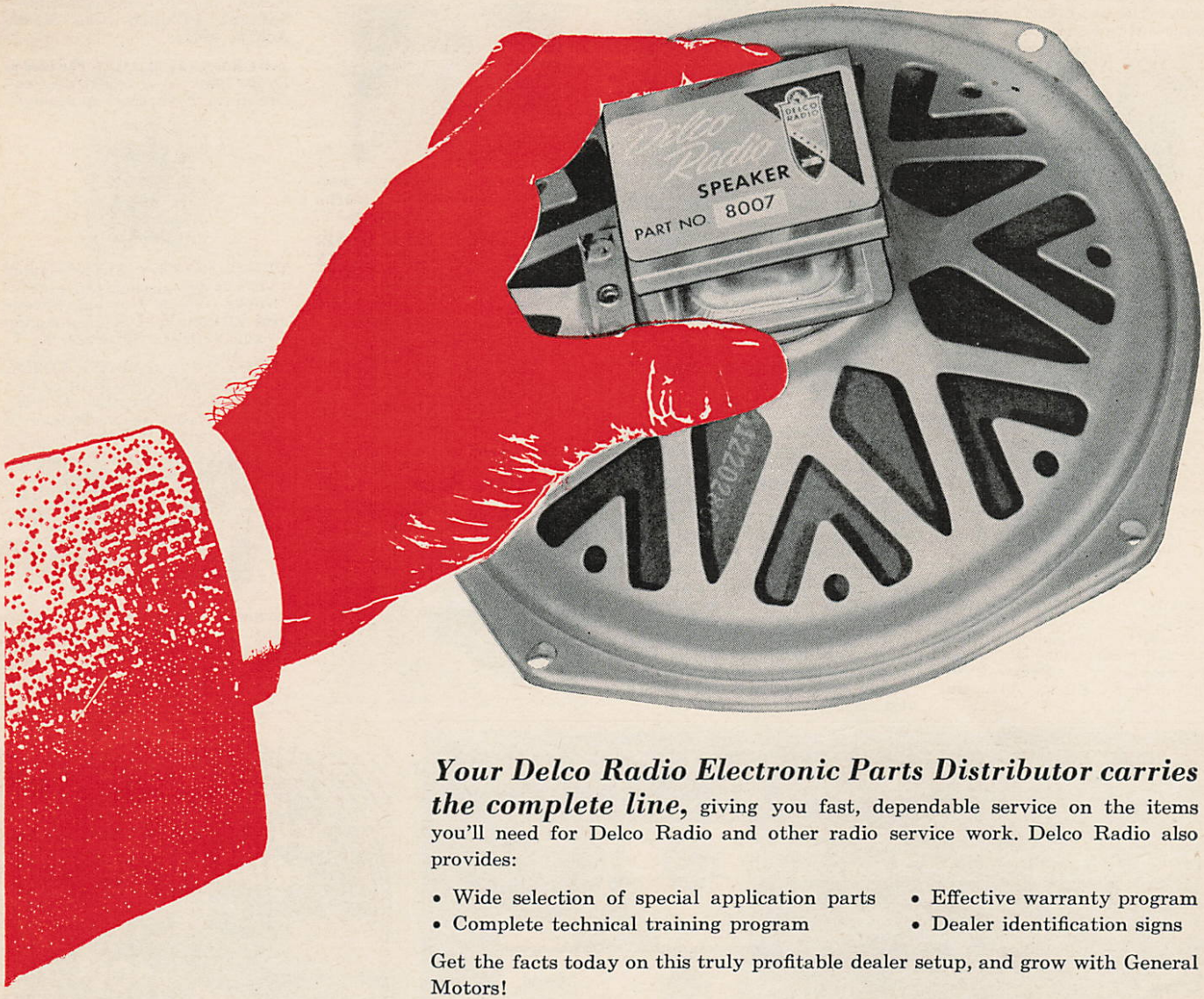

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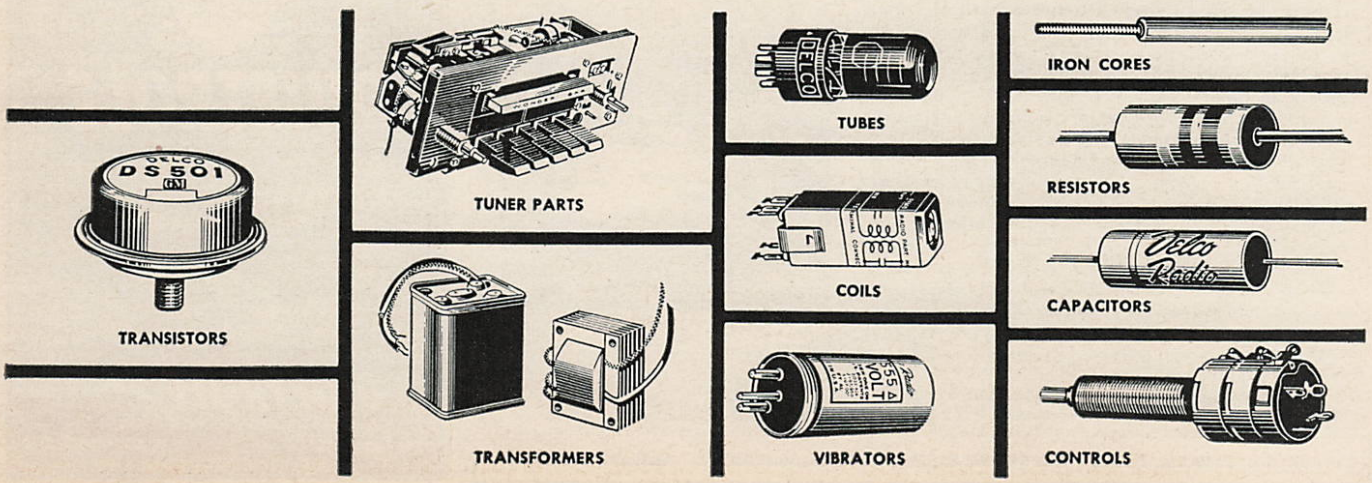
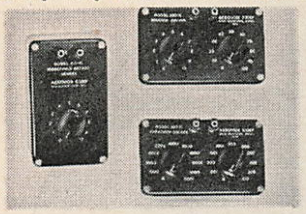
DIVISION OF GENERAL MOTORS, KOKOMO, INDIANA



of transistor types.—**Triplett Electrical Instrument Co.,** Bluffton, Ohio.

DECADE BOXES. Complete line of 10 models: 3 capacitance, 3 resistance, 4 inductance. Heavy-duty construction. Multi-

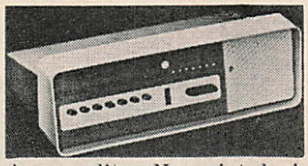


ple-dial units have highest value multiplier on left-hand side so that readings are in order when read.—**Aerovox Corp.,** Distributor Div., New Bedford, Mass.

GARAGE-DOOR OPERATOR, *model G-500.* Quieter operation and greater efficiency than previous models. Radio-controlled. Gear type speed reducer uses double helix gear. ¼-hp 117-volt

capacitor-start motor. Automatic shutoff. Crystal-controlled transmitter uses plug-in coded channel modulation to prevent interference. — **Perma-Power Co.,** 3100 N. Elston Ave., Chicago 18, Ill.

INTERCOM SYSTEMS, *Ektacom E* and *W 601* series. Pre-

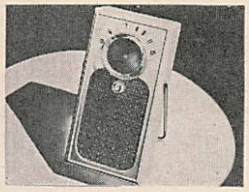


mium quality. No printed circuits. More than 5 watts audio output when driven with 2-mv input.—**Fisher Berkeley Corp.,** 4224 Holden St., Emeryville, Calif.

HAM TRANSMITTER KIT, *Heathkit Apache.* 150-watt phone and 180-watt CW inputs.

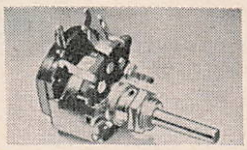
Built-in switch-selected circuitry provides for single-sideband transmission with plug-in external adapter. Vfo provides low-drift frequency control. Rotating slide-rule vfo dial. Bandswitch gives quick selection of amateur bands on 80, 40, 20, 15 and 10 meters. Adjustable low-level speech clipping and low-distortion modulator stage with 6CA7 tubes in push-pull class-AB operation. Time-sequence keying. Pi-network output coupling matches impedances between 50 and 72 ohms.—**Heath Co.,** Benton Harbor, Mich.

TRANSISTOR RADIO KIT, *Sextette.* 6 transistors, 3 if transformers, push-pull audio output, loopstick antenna, full-action avc. Prepunched printed-



circuit board. Unbreakable case. —**Superex Electronics Corp.,** 4-6 Radford Pl., Yonkers, N. Y.

MINIATURE POTENTIOMETER, *series 44.* Rated at 0.2 watt. Body diameter 21/32 inch, depth 23/64 inch, shaft

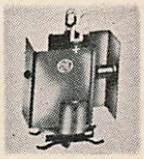


½ inch. Standard ohmages of 25K and 500 K with W taper.—**Clarostat Mfg. Co.,** Dover, N. H.

FILM CAPACITORS, *Isofarad* line. Plastic-film dialectric paper tubular units have capacitance stability of ±0.5% over oper-

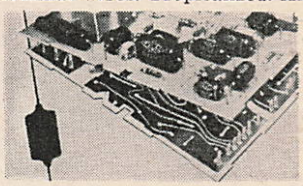
ating temperature of 25–80°C. Premolded phenolic housing and plastic resin and seals protect against moisture and mechanical damage. For TV–radio replacements and lab instruments.—**Sprague Products Co.,** North Adams, Mass.

GERMANIUM RECTIFIERS, *1N008* and *1N016.* Replace entire line of direct replacement



TV set rectifiers. Snap-in type. *1N008* is 400-ma half-wave unit; *1N016,* 400-ma doubler.—**General Electric Co.,** Semiconductor Products Dept., Syracuse, N. Y.

MOLDED CAPACITORS, *Wima Tropidur.* For printed and conventional circuits. Hot-dip fusing process seals element to terminal wires. Tropicalized. Air



inclusion prevented by applying coating in vacuum.—**Rhombic Associates,** 60 W. 45 St., New York 36, N. Y. END

All specifications on these pages are from manufacturers' data.

PENTRON STEREO

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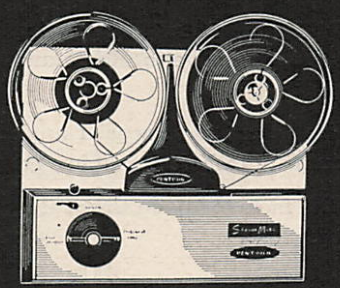
TAPE RECORDERS



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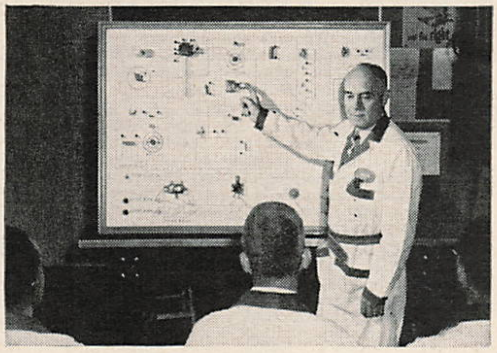

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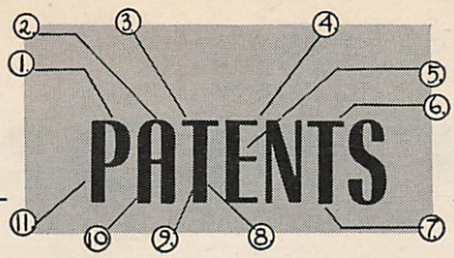
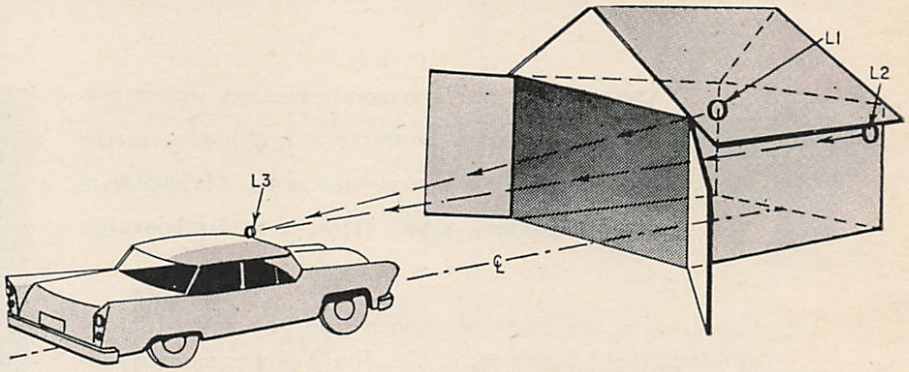


PARKING ALONG THE BEAM

Patent No. 2,818,553

David Lawrence Jaffe, Great Neck, N. Y.
(Assigned to Polarad Electronics Corp., Brooklyn, N. Y.)

Here is a solution to the problem of the big car and little garage. A radio beam guides the driver as he moves in or out, the signal being received on the car radio.



Two directional loops (L1 and L2) are mounted symmetrically at the rear of the garage. They are energized by rf, each out of phase with the other. Each is modulated with a different audio tone. At any point midway between the loops the fields cancel. If the car is off center, its radio antenna (loop L3) will receive one carrier more strongly than the other, and the corresponding tone is heard. To park the car correctly, the driver merely steers so that he is always along the null line.

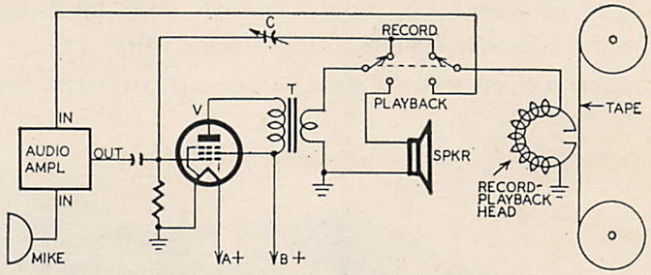
The inventor suggests shorting out the radio's avc for maximum sensitivity while using this parking guide.

PORTABLE TAPE-RECORDER CIRCUIT

Patent No. 2,810,791

Ralph West, Oceanside, and Kalju Meri, Astoria, N. Y. (Assigned to Mohawk Business Machines Corp., New York, N. Y.)

A single tube can combine the functions of signal amplifier and bias voltage generator. The dual-function tube (V) is shown as a filament type for battery operation. Other tubes (not shown) are in the main amplifier.



When switched to RECORD, the tube's output is fed back through T and C for oscillation at some predetermined ultrasonic frequency. Bias amplitude is adjusted by C. At the same time, the tube adds its gain to the output from the amplifier. The mixed bias–audio voltage is delivered to the recording head.

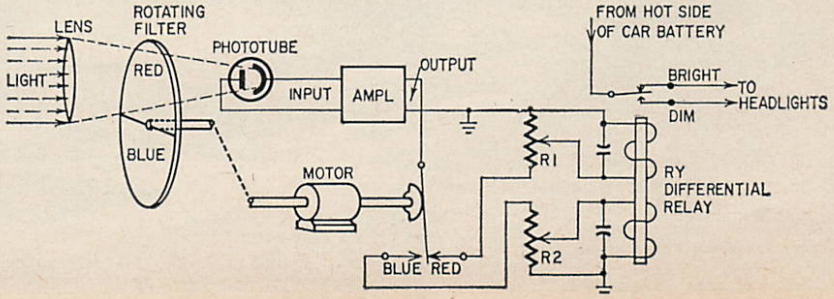
Switching to PLAYBACK connects the magnetic head to the amplifier input. Output from V appears across the speaker for tape reproduction.

HEADLIGHT DIMMER

Patent No. 2,827,594

Jacob Rabinow, Takoma Park, Md.

Your headlights should be dimmed when you travel behind another car moving in the same direction or when a second car approaches in the opposite direction. This avoids confusing the



driver up ahead or blinding an approaching driver. This automatic device responds automatically both to a strong (white) headlight or to a weak (red) taillight.

The received light beam passes through a lens and a motor-driven filter to the phototube. The same motor drives a synchonous vibrator which closes the "red" contacts while the red filter is in position, and so on. Separate outputs from the vibrator are adjusted by R1 and R2, which feed the coils of relay RY. As long as these outputs are equal (but opposite) the relay is not energized.

Light from a taillight is nearly all red, so the output of the red contact is high and that of the blue contact of the vibrator is practically zero. Therefore the relay closes, dimming the headlights.

Light from the headlights of an approaching vehicle contain quantities of both red and blue light so R1 and R2 are adjusted to provide enough of a difference in red and blue outputs to close the relay.

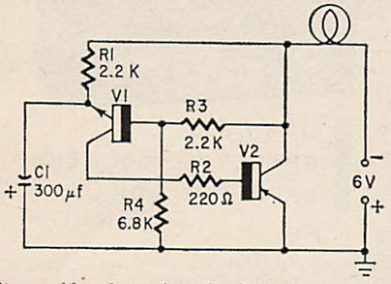
Now, either approaching headlights or creeping up on the taillights of the car ahead will dim your lights. Of course, after the approaching car has passed or you have passed the car ahead, the bright lights go on again—with no light in front of you there is no output from the red or blue contacts and the relay opens.

BLINKER

Patent No. 2,829,257

Elihu Root, 3d, Clinton, N. Y. (Assigned to R. E. Dietz Co., Syracuse, N. Y.)

This blinker controls a low-voltage lamp. It can be used as a safety flasher—for example, near a stalled car. The car battery could be the power source. One transistor (V1) is a control unit, while the other (V2) must be a power



unit capable of passing the high lamp current.

Initially, V1 and V2 are cut off and current flows through R1 to charge C1. V1's emitter goes progressively more negative and soon the transistor conducts. Current flowing through R2 drives V2 to conduction also, permitting lamp current to flow through this transistor. As the lamp voltage rises, V1's base goes still more positive until both transistors are saturated and the lamp is fullly lit.

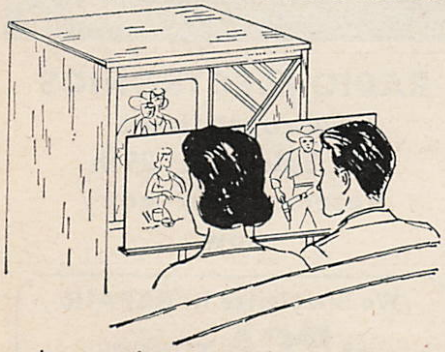
C1 begins to discharge through the transistors, continuing until its voltage becomes too low to support further flow through them. At this point, the transistors block and the cycle repeats.

DUAL-IMAGE TV SET

Patent No. 2,832,821

Allen B. DuMont, Cedar Grove, N. J. (Assigned to Allen B. DuMont Labs, Inc.)

This TV receiver has two picture tubes and can reproduce two different images at once. Both pictures are superimposed on a single screen. A polarized sheet is used to filter out



one image, so that a viewer sees only the desired show.

The image from one kinescope is viewed directly, while that of the other is reflected. This polarizes them oppositely and makes it possible to separate them by oppositely polarized glasses or panels. The diagram shows how two viewers may watch different programs at once.

To avoid conflict of sound, each viewer wears an earpiece END

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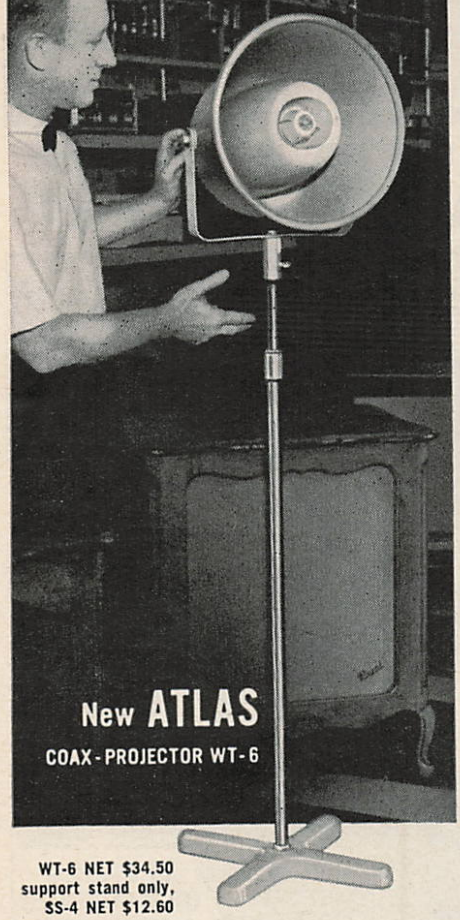

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Universally adjustable "U"-type rugged steel mounting . . . finished in high temperature baked modern beige enamel.

Power Rating	15 watts continuous
Freq. Resp.	140-15,000 cps
Impedance	8 ohms
Dispersion	120°
Dimensions	Bell opening 15", overall depth 12"

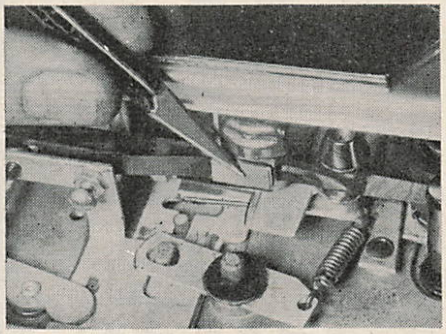
See the WT-6 at your local distributor.
Send for complete catalog. RE-1.

ATLAS SOUND CORP.
1449-39 St., Brooklyn 18, N. Y.
Atlas Radio Ltd., Toronto, Canada

Technotes

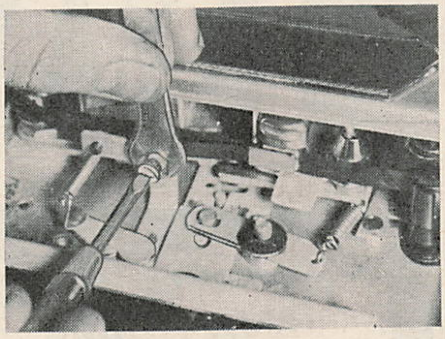
TAPE RECORDER SERVICING

Loss of volume or high-frequency response in a tape recorder can often be traced to the pressure pad (Fig. 1) not holding the tape firmly against the head. After the recorder has been used



for quite some time without the spring-tension screw being adjusted, the spring tends to loosen up.

To tighten the spring tension, start a tape running through the machine on playback, loosen the small nut which holds the screw tight and tighten the screw for more tension (Fig. 2). (Adjust the screw for firm tension but



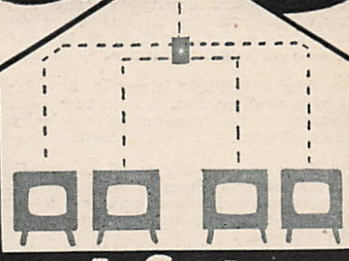
not so firm that tape passing through the head tends to slow down.) The increased pad pressure will hold the tape firmly against the head and insure that none of the intelligence on the tape will pass by unreproduced.—*Scott Mock*

SWAPPED 3.58-MC CRYSTALS

Recently, I was called into a service shop to take a look at a color TV receiver which would not lock color. The color signal was present but appeared in the form of several rainbows across the screen, drifting back and forth. No adjustment of the color discriminator balance control would help, although it would reduce the number of rainbows and almost bring the color sync into lock.

Tubes had been replaced, the reactance tube tank and the color oscillator slug were varied through their entire ranges with no results. All operating voltages were within tolerance.

I Antenna



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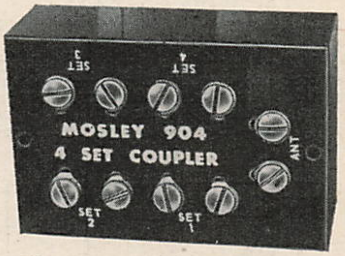

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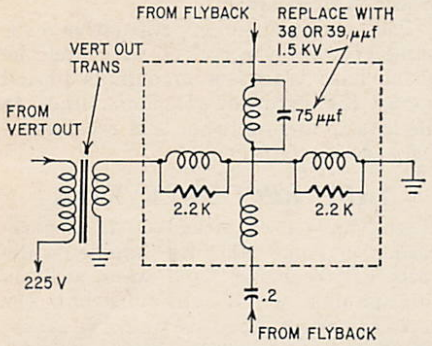
Finally I suspected that the color oscillator crystal might have become defective, although this seemed remote. Discussion brought up the possibility that the technician might have mixed up the crystals for the color bar generator and the receiver—both were stamped 3.579545 mc.

The possibility was checked by swapping the crystals. Sure enough, a little touchup of the color sync controls restored perfect reception. Apparently, the color bar generator signal was thrown off frequency by the receiver crystal, just as the receiver was thrown off frequency by the generator crystal. Both were stamped with the same frequency but each operated properly only in the circuit for which it had been intended.—*Robert G. Middleton*

MAJESTIC MODELS 99 TO 105

Ringing due to insufficient damping in the horizontal deflection circuit has been traced to the 75-$\mu\mu$f capacitor



across half of the horizontal yoke winding. Replace this unit with a 38- or 39-$\mu\mu$f 1,500-volt capacitor to eliminate the trouble.—*John A. Comstock*

PACKARD-BELL MODEL 2101

Trouble: nonlinear retrace lines top half of raster.

Check for slightly leaky capacitor across primary of vertical output transformer. If, with new capacitor installed, trouble returns in a short time, try a new transformer—the one in the set may have shorted turns.—*William Porter*

END

Answer to Electronic Crossword on page 39

1 H	I	F	2 I		3 S	C	O	4 P	E		5 W	6 A	T	7 T
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15 C	A	P	A	C	I	16 T	O	17 R		S		R		I
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19 R	E	A	C	T	A	N	C	E		S		20 A	F	T
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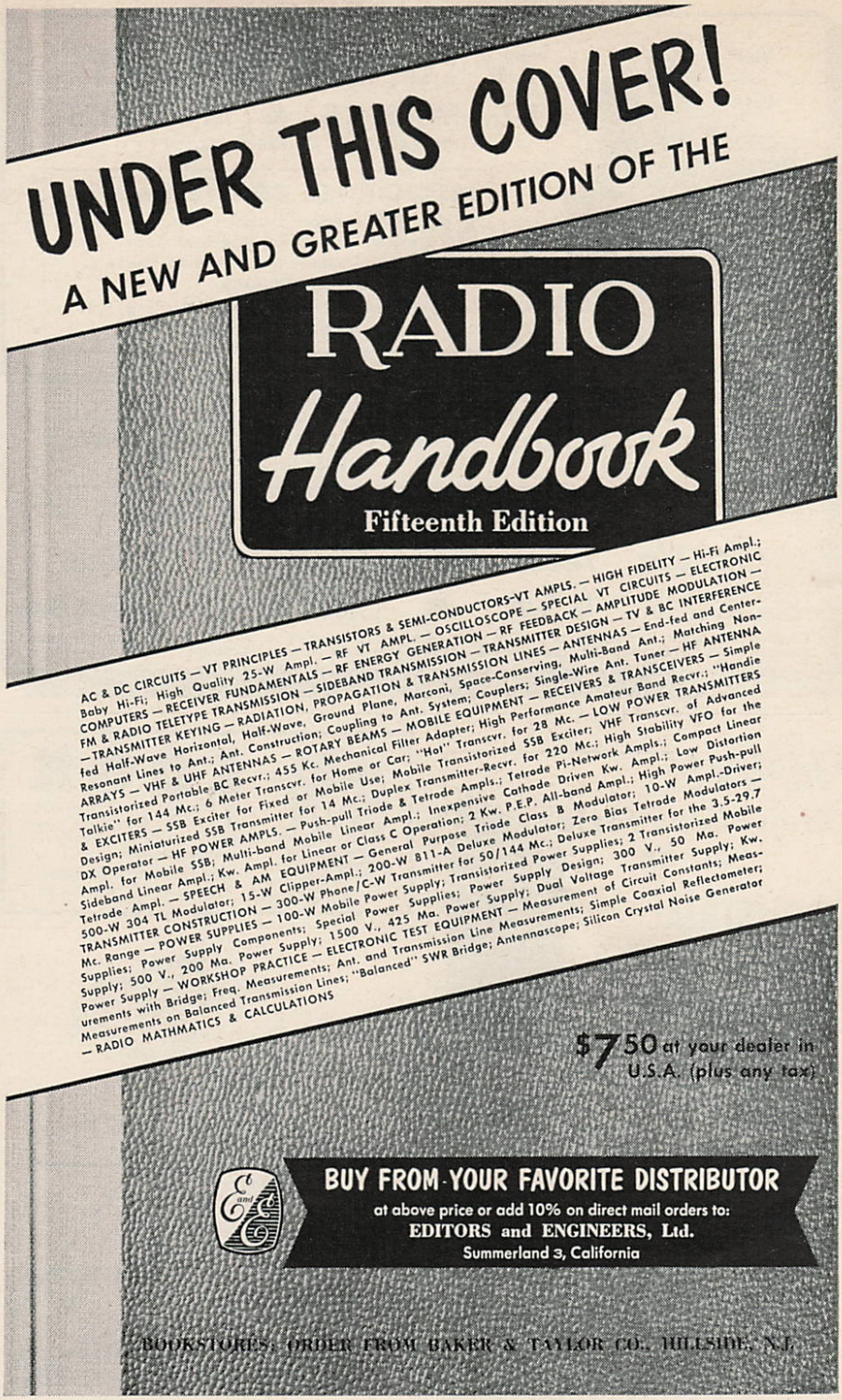
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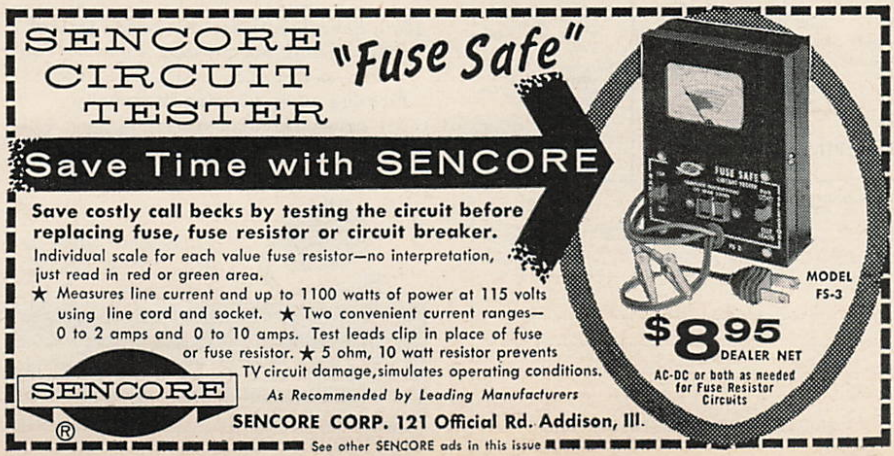
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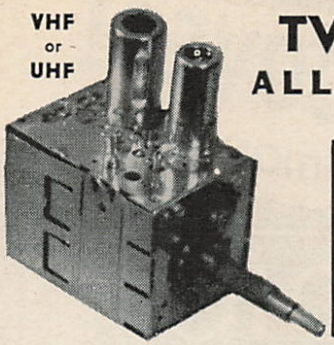

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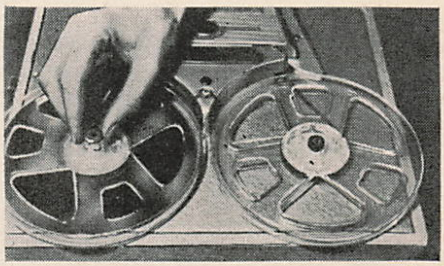
TELEPHONE ANTENNA

Many a technician has encountered the landlord who would not stand for an outdoor antenna. A simple solution to this problem is to take a 10-foot length of insulated indoor antenna wire and wrap one end into a 4-inch coil of about 6 turns. Place this coil under the base of a desk telephone and fasten the other end to the antenna terminals of the AM receiver.

The electrostatic or capacitive coupling between the coil of wire and the phone base transfers rf signals picked up by the external telephone lines to the lead-in and on to the AM receiver.—*John A. Comstock*

TAPE RECORDER KINK

If you have ever picked up a tape recorder by its carrying handle while reels of recording tape were still on the spindles, you'll remember how the reels of tape slipped off and fell crashing to the floor in a tangled mess. After this little incident happened to me recently, I decided to take measures to keep it from happening again. Before I pick up the recorder when there are reels of tape on the spindles, I slip a tight-fitting rubber grommet over each spindle. This keeps the reels of tape from slipping off.—*Scott Mack*



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You can add inverse feedback to an audio amplifier, radio, TV set or small phonograph in a very simple manner. Just disconnect the plate load resistor of the first audio tube from B-plus and connect it to the plate of the output tube. Thus, that resistor now serves as both a plate load and a feedback resistor. The degree of feedback can be changed by changing the value of this resistor—lower values for more feedback.—*Charles Erwin Cohn*

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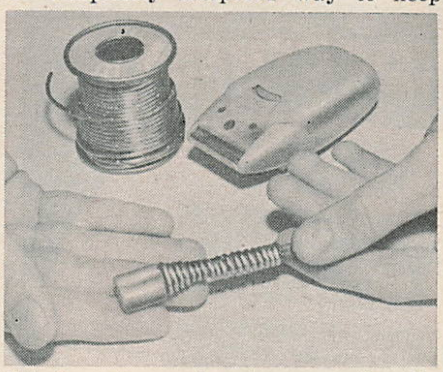
old electrical problem. How do you keep a power cord from wearing out near its connector? Flexing of the cord during normal use eventually results in complete breakdown of the wires and insulation. Although there probably is no completely foolproof way to keep



this from happening, try wrapping the cord with solder near the connector, as shown in the photograph. The solder provides additional support for the wires and insulation, and won't eventually wear out as will a wrapping of waxed lacing twine or tape.—*J. A. Compton*

STORING RECORDED TAPES

After purchasing a tape recorder I went out and recorded reels full of almost anything that made noise. I shortly discovered I had reels and reels of tape, but no safe place to keep them. A look around the kitchen solved the problem—empty potato-chip cans. They are about 7¼ inches in diameter and about 10 inches high—good for holding twenty 7-inch reels. Smaller cans for smaller reels can also be obtained and are very convenient.—*Gerald Samkofsky, W2YSF*

HANDY REAMER

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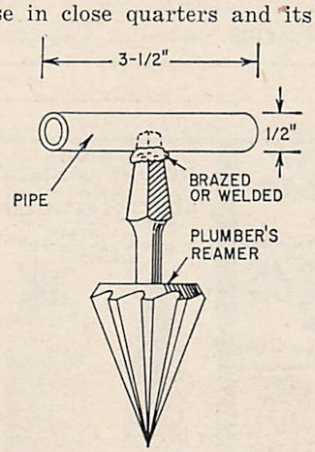

diameter makes it more versatile than the usual T-handle reamer. Drill a hole in the pipe large enough to accept part of the reamer's shank, then braze it in place. You are sure to find this modified reamer a handy addition to your bench tools.—*John A. Comstock* END

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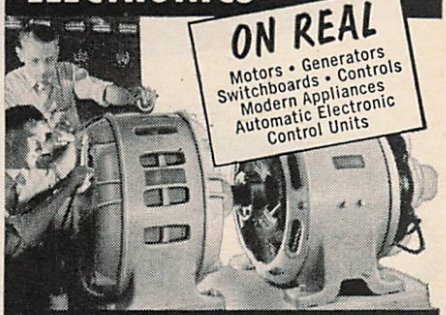

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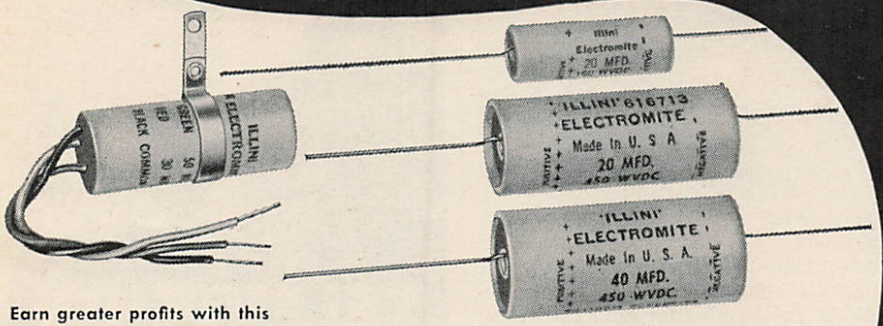

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NO-NOISE NEW RUBBER COAT SPRAY

- Insulates where applied
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- Waterproofs thoroughly
- Non-inflammable
- Contains no plastic

6 Oz. Spray Can $3.25 Net To Servicemen

NO-NOISE TUNER-TONIC With PERMA-FILM

- Economical—a little does a lot.
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NOT A CARBON TET SOLUTION

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ELECTRONIC CHEMICAL CORP. 813 Communipaw Avenue Jersey City 4, N. J.

BUSINESS and PEOPLE

Joseph N. Benjamin (left), former executive vice president of Pilot Radio Corp. has been appointed president of the Bogen-Presto Div. of the Siegler Corp., Paramus, N. J., where he will direct all activities of the high-fidelity

and recorder manufacturer. **John G. Brooks**, president of the Siegler Corp., has been named to the board of directors of the Electronic Industries Assn. (EIA).

Robert C. Sprague (right), board chairman of the Sprague Electric Co., North Adams, Mass., congratulates president **Harry Kalker**, of Sprague

Products Co., who has headed the subsidiary for the 25 years of its existence. Founded in 1933, it followed the establishment of the parent company by 7 years.

Philip M. Pritchard has been named marketing manager for entertainment electronic components by General Instrument Corp., with headquarters in Newark, N. J. He will be responsible for the marketing of the company's TV and radio components. He was formerly general sales manager, Parts Div., Sylvania.

C. R. (Russ) Robertson, sales manager, was elected vice president–sales by Weller Electric Corp., Easton, Pa., manufacturer of soldering guns and other tools.

H. D. Johnson, vice president and director of the Hickok Electrical Instrument Co., Cleveland, has been ap-

pointed director of marketing as part of the company's expansion.

Myron S. Friedman (left) has been promoted to manager of branch operations of all stores owned by the Radio Shack Corp., Boston—two in Boston

and one in New Haven. **Alfred E. Coe** joins the company as manager of the Amateur Sales Div.

Dr. Philip N. Hambleton became supervisor of research and development–tubes for CBS-Hytron, Danvers, Mass. He was previously senior physicist in the Tube Research and Development Laboratory.

Gordon R. Vance was elevated to manager, sales coordination, distributor sales, RCA Electron Tube Div. He has been manager product controls–industrial tubes, in the Distributor Products Dept.

Harold J. Adler was appointed vice president in charge of operations for Shure Brothers Inc., Evanston, Ill., manufacturer of microphones and electronic components. He has been vice president of the Edwin I. Guthman Co., engineering director of Hallicrafters and chief electrical engineer of the Sentinel Radio Co.

Walter L. Brough has been named to the new post of manager, Manufacturing Div., OR-Radio Industries Inc., Opelika, Ala. He was formerly executive vice president of Hercules Motors Corp., Canton, Ohio.

Unit production and sales

	First 9 months	
	1958	1957
TV Set Production	3,572,189	4,589,164
Radio Set Production	8,178,821	10,376,354
FM Radio Production	176,061	not given
TV Retail Sales	3,468,090	4,452,081
Radio Retail Sales	*4,903,676	5,840,372
TV Picture Tube Sales	5,844,665	7,308,552
Receiving Tube Sales	291,718,000	341,663,000
Transistor Sales	30,387,277	17,842,300

* Excluding auto receivers
Source—EIA

GIANT NEW YEAR'S SALE OF LEKTRON

POLY-PAKS© 88¢

OVER 500,000 SOLD AT $1 EACH!

FREE! Buy 10 Poly-Paks, PICK ELEVENTH FREE!

FREE! Surprise Gift With Every Order

70 ONE-WATTERS ☐ Asstd. value carbon resistors. 5%, too! **88¢**

100 HALF-WATTERS ☐ Asstd. value carbon resistors, incl. 5%! Reg. $12. **88¢**

70 HI-Q RESISTORS ☐ Carbon, IRC, Ohmite, 1%, too! ½, 1 & 2 W; 10 ohms to 10 megs. 2 lbs. Reg. $13. **88¢**

20 CAMEL HAIR BRUSHES ☐ 100% pure bristle, sizes 1-6. Reg. $2.50. **88¢**

1500 PCS. HARDWARE ☐ Nuts, screws, washers, etc. 1½ lbs. Reg. $6. **88¢**

5-IN-1 DRILL BIT ☐ Reams, saws, shapes, drills, copes. Fits hand or electric drill. **88¢**

8 GERMANIUM DIODES ☐ w/long leads. Glass sealed. Reg. $5. **88¢**

60 SUB-MINI RESISTORS ☐ ¼" long, 20 values; ⅓ W, to 10 megs. Reg. $6. **88¢**

70 TUBULAR CONDENSERS ☐ Paper, molded, oil, porc. .0002 to .5mf, to 1000 V. 2 lbs. Reg. $14. **88¢**

300 FT. HOOKUP WIRE ☐ Tinned, asstd colors, sizes. 2 lbs. Reg. $5. **88¢**

POSTAGE STAMP MIKE ☐ Crystal; 100 to 8,000 cycles-per-sec. 1 lb. Reg. $7. **88¢**

70 TERMINAL STRIPS ☐ Solder lug & binding; to 20 terminals. 2 lbs. **88¢**

75 MICA CONDENSERS ☐ .00025 to .01 to 1200 V. Silver, too. 25 values. Reg. $28. **88¢**

SYLVANIA TV MIRROR ☐ 10x12" stainless steel. Many uses! 2 lbs. Reg. $4. **88¢**

40 TUBE SOCKETS ☐ 4 to 9-pin; ceramic, mica, shield-based incl. 2 lbs. Reg. $10. **88¢**

NEW FOR '59! Do-It-Yourself-N-Save SIX TRANSISTOR RADIO KIT ☐ All parts. Includes carrying case, batteries, instructions. (Less transistors, diode). Wt. 2 lbs. **$15.99**

$25 SURPRISE PACK! ☐ Large & varied asst. radio & TV parts. 3 lbs. **88¢**

75-PC. RESISTOR SPECIAL! ☐ WW, precision, carbon, variable, mini types. 3 lbs. Worth $15. **88¢**

60-PC. CONDENSER SPECIAL! ☐ Molded, paper, ceramic, oil, mica, discs, variables. 2 lbs. **88¢**

10 ELECTROLYTICS ☐ Radio, TV. 10-500 mf to 450 VDC. 3 lbs. Reg. $12. **88¢**

12 POLY BOXES ☐ Clear plastic, hinged, w/snap locks. Asstd. sizes. 1 lb. **88¢**

125 CERAMIC CONDENSERS ☐ Hi-Q discs, tubulars. To .01 mf. 2 lbs. Reg. $12.50. **88¢**

10 PANEL SWITCHES ☐ Asstd. 115 VAC, power, multiple circuit & SPST, DPST, DPDT. 2 lbs. Reg. $5. **88¢**

70 COILS, CHOKES ☐ IF, RF, ant., slug-tuned, too. 3 lbs. Reg. $15. **88¢**

400-FT. HOOKUP WIRE ☐ Factory-cut for hobby use. Tinned, w/asstd. insulation, colors. 3 lbs. **88¢**

40 PRECISION RESISTORS ☐ 1%, ½ & 1W; carboloy & WW. 100 ohms to 1 meg. Reg. $17. **88¢**

60 KNOBS, RADIO & TV ☐ Asstd. colors, insulation. Some worth $1 ea. 2 lbs. Reg. $17. **88¢**

35 POWER RESISTORS ☐ WW, 5 to 50W, to 10,000 ohms; incl. vitreous. 3 lbs. Reg. $15. **88¢**

20 PRINTED CIRCUITS ☐ Built-in R/C circuits, incl. integrals. 1 lb. Reg. $7. **88¢**

40 HI-Q CONDENSERS ☐ Finest porcelain. NPO's too! 1 lb. Reg. $6. **88¢**

15 VOLUME CONTROLS ☐ Incl. duals; some w/switch. To 1 meg. 2 lbs. Reg. $12. **88¢**

8 TRANSISTOR SOCKETS ☐ Mica-filled. For sub-mini tubes, too. **88¢**

SUN BATTERY ☐ Similar to famed B2M 1" long. Reg. $2.50. **88¢**

15 ROTARY SWITCHES ☐ Asstd. gangs. 3 lbs. Reg. $12. **88¢**

15-PC. TWIST DRILL SET ☐ 1/16" thru ¼" by 64ths, w/calibrated case. Reg. $3. **88¢**

40 DISC CONDENSERS ☐ Wafer-thin, to .01 mf. Reg. $5. **88¢**

4 OUTPUT TRANSFORMERS ☐ 50L6, etc. 3 lbs. Reg. $8. **88¢**

8-PC. NUTDRIVER KIT ☐ $3 value. Plastic handle, 3/16, 7/32, ¼, 5/16, 11/32, ⅜, 7/16" steel socket wrenches in plastic case. 1 lb. **88¢**

WORLD'S SMALLEST RADIO ☐ 2x1x1". Kit includes loopstick, jacks, diode, etc. w/instructions. 1 lb. Reg. $3. **88¢**

2 P-N-P TRANSISTORS ☐ Popular make. For hundreds of projects. $5 value. **88¢**

4 POWER WOOD BITS ☐ Hi-Q steel. ⅜, ½, ¾ & 1". For drills, presses. 5" long. Reg. $3. **88¢**

WIRE STRIPPER ☐ Strips & cuts hook-up wire, sizes #16 thru #22. Wt. 1 lb. **88¢**

2 MIKE TRANSFORMERS ☐ Carbon. Imp. 100 to 100K ohms. Leads, encased. 2 lbs. Reg. $10. **88¢**

2 VARI-LOOPSTICKS ☐ Adj. 540 - 1500 Kcs. Transistor radios. etc. 1 lb. **88¢**

30 MOLDED CONDENSERS ☐ Assorted. Finest made! Wt. 2 lbs. **88¢**

2 TRANSISTOR IF'S ☐ Double-tuned. Only ½" square. 456 kcs. **88¢**

60 PLUGS, RECEPTACLES ☐ Audio, powerspeaker etc. 2 lbs. **88¢**

150 CARBON RESISTORS ☐ ½ to 2 W; 15 ohms to 1 meg. Incl. insulated types. 2 lbs. **88¢**

TV PIC BOOSTERS ☐ Parallel, 6-wire. Extends pic tube life. Wt. 1 lb. **88¢**

3 AC-DC CHOKES ☐ for power supplies 50 to 200 ma. Open frame. 3 lbs. Reg. $9. **88¢**

TEN 3-SECOND TIMER ☐ mechanisms. Precision geared. 2 lbs. Reg. $30. **88¢**

40-RECORD CADDY ☐ Wrought iron. Holds 40 records & albums. 3 lbs. Reg $2.98. **88¢**

7 SCREWDRIVERS/ RACK ☐ Asstd. screwdrivers w/ plastic handles, incl. Phillips. Wall rack. List $3.50. 1 lb. **88¢**

HOBBY BENCH VISE ☐ Clamp type, fits tables, too. Many house, shop, hobby uses. Steel. 1 lb. **88¢**

FILAMENT TRANSFORMER ☐ 115/1/60 cycles to 6.3 VCT @ 1.5A. 2 lbs. Reg. $4. **88¢**

6 SILICON DIODES ☐ Sylvania 1N22, 1N23. Reg. $36. **88¢**

4 TRANSISTOR OSC. COILS ☐ for printed circuit & transistor portable radios. Reg. $5. **88¢**

5 ROLLS "MICRO" WIRE ☐ Sizes 24 thru 32, for transistor & sub-mini circuits. 1 lb. **88¢**

6 FERRITE CORES ☐ Asstd. to 6", flat & round. Hi-Q ferrite. 2 lbs. Reg. $5. **88¢**

JEWELERS' PLIERS ☐ Chrome plated, drop-forged steel. Side or diagonal cutters. For fine precision work. 1 lb. Reg. $3. **88¢**

40 SUB-MINI CONDENSERS ☐ For transistor, printed circuit work. 1 lb. Reg. $7. **88¢**

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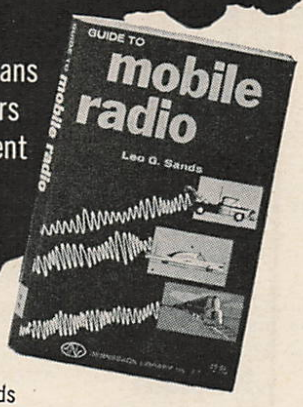
- equipment buyers



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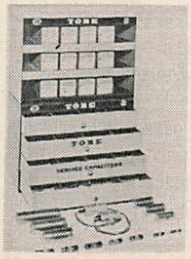
Electro-Voice Inc., Buchanan, Mich., has launched the largest promotion in its history for its high-fidelity speakers and enclosures, keyed to the theme, "Step Up to Stereo." Heavy national

and local advertising will feature a free stereo demonstration and a free 12-inch record recorded stereophonically on one side and monophonically on the other.

Service Instruments Corp., Addison, Ill., is offering a $2.75 Sencore filament

checker free with each purchase of the Sencore TV bias supply and the Sencore Vibradaptor.

Tobe Deutschmann Corp., Indianapolis, has announced the Tobe Twins, enameled metal merchandising cabinets



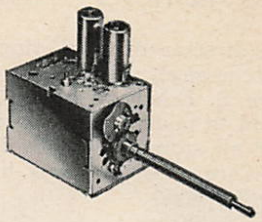
containing 12 twist-prong capacitors, 16 Jet tubular electrolytics and 73 TPM mylar tubulars.

Tung-Sol Electric Inc., Newark, N. J., is merchandising its performance-matched 6550 and 5881 beam power amplifier tubes twin-packed in pairs for optimum hi-fi performance.

Jensen Industries, Forest Park, Ill., calls its new phono needle display the dangling dozen. It holds 12 needle packages in clear plastic bags. As each is sold, an automatic "sold" signal reminds the dealer to replace the needle.

Michigan Magnetics' new Distributor Div., Chicago, is shipping tape recorder

heads to jobbers in a new package. The clear plastic box contains a die-cut urathene pad into which the head fits precisely. Every package contains 20 feet of recorder tape bearing a 10,000 cycle note for proper head installation. END



Now YOU can get TUNERS repaired, or replaced, in a hurry! *Send them to TARZIAN!*

● Sarkes Tarzian, Inc., announces a new tuner repair service and factory replacement program for Tarzian-manufactured tuners. Distributors, dealers and servicemen will welcome this direct factory service program which is designed to take delay and confusion out of the tuner repair business.

We're set up to offer a 48 hour service from the date of receipt to shipment to you.

Cost is reasonable, too. Only $7.50 per unit ($15 for UV combinations) and that includes ALL replacement parts! Both repaired —or exchange units if available from stock—carry a 90 day warranty against defective workmanship and part failure.

Replacements will be offered at these current prices* on units not repairable:

VHF 12 position tuner...	**$17.50**
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VHF/UHF combination.	**25.00**
UHF only.....	**15.50**

*Subject to change

When inquiring about tuner service, always refer to tuner by part number. When inquiring about direct replacements for tuners other than Sarkes Tarzian-manufactured, please indicate tube complement, shaft length, filament voltage, series or shunt heater. Use this address for quickest service:

SARKES TARZIAN, Inc.
Att: **Service Mgr., Tuner Division**
East Hillside Drive
Bloomington, Indiana

TARZIAN Electronic Product and Services include TELEVISION TUNERS . . . SELENIUM AND SILICON RECTIFIERS . . . BROADCAST EQUIPMENT . . . AIR TRIMMERS . . . TV STATIONS WTTV and WPTA, and RADIO STATION WTTS.

LITERATURE

Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead—do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears. UNLESS OTHERWISE STATED, ALL ITEMS ARE GRATIS. ALL LITERATURE OFFERS ARE VOID AFTER SIX MONTHS.

ELECTRONIC EQUIPMENT *Catalog No. 69* covers thousands of industrial electronic, amateur, radio, TV and hi-fi items in its 388 pages. It's fully illustrated and contains a product and manufacturer index.—**Newark Electric Co.**, 223 W. Madison St., Chicago 6, Ill.

RECORDING TAPE *Cross Reference Chart*, available to dealers, gives catalog number and trade name for each type of tape made by 4 leading manufacturers. Reverse side contains playing-time chart. — **ORRadio Industries Inc.**, Shamrock Circle, Opelika, Ala.

WINDOW POSTER boosting the independent TV technician, with legend, "Your TV Technician Guarantees You the Best Seat in the House."—**Sprague Products Co.**, North Adams, Mass. 10c.

SILICON CONTROLLED RECTIFIER, newly developed semiconductor, is described in a 17-page booklet, *Application Notes for ZJ-39A Silicon Controlled Rectifier*, publication *No. ECG-327*. General circuit design considerations, firing circuit design and typical applications are covered.—**General Electric Co.**, Semiconductor Products Dept., Syracuse, N. Y.

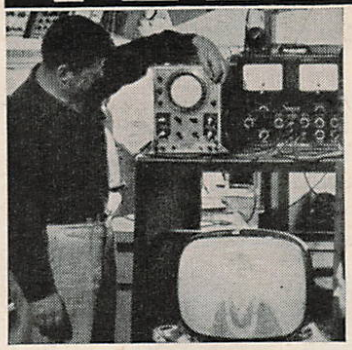
PHONO AND RECORDER *Drive Replacement Chart* is offered to qualified electronic technicians. The 21 x 34-inch chart has actual-size illustrations of each unit, with price, conversion and cross-reference information. — **Walsco Electronic Mfg. Co.**, 100 W. Green St., Rockford, Ill.

STEREO RECORDS AND TAPES of most major manufacturers are listed in a new catalog, *Stock No. 68 R 566*. More than 200 discs and nearly 500 tapes are included.—**Allied Radio Corp.**, 100 N. Western Ave., Chicago 80, Ill.

SPEAKERS AND ENCLOSURES and dividing networks in the complete JBL line are illustrated and described in *catalog SC504*. A table gives prices at a glance for every combination of speakers and enclosures.—**James B. Lansing Sound Inc.**, 3249 Casitas Ave., Los Angeles 39, Calif.

KIT CATALOG. Complete indexed 1959

TELEVISION



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You can now purchase all your HI-FI from one reliable source and be assured of perfect delivery. Carston makes delivery from NY stock on most Hi-Fi, Recorders and tape within 24 hours. **SEND US A LIST OF YOUR HI-FI REQUIREMENTS FOR OUR WHOLESALE QUOTATION** and our FREE wholesale catalogue.

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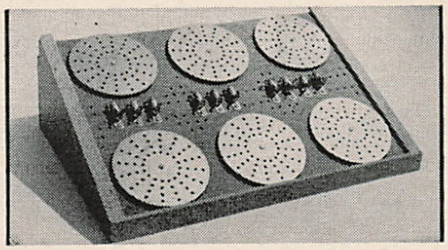
Can you think . . . faster than this Machine?



Control Panel of GENIAC set up to do a problem in check valve research.

Be careful before you answer. GENIAC® the first electrical brain construction kit is equipped to play tic-tac-toe, cipher and encipher codes, convert from binary to decimal, reason (in syllogisms) as well as add, subtract, multiply and divide. Specific problems in a variety of fields—actuarial, policy claim settlement, physics, etc., can be set up and solved with the components. Connections are solderless and are completely explained with templates in the manual. This covers 125 circuits and shows how new ones can be designed.

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SEND for your GENIAC® kit now. Only $19.95 with over four hundred components and parts, fully illustrated manual and wiring diagrams. We guarantee that if you do not want to keep GENIAC® after one week you can return it for full refund.

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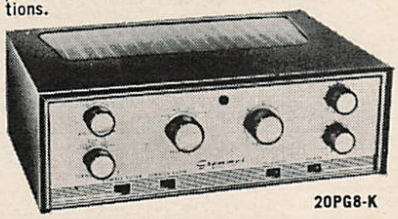

20PG8-K

20PG8-K 20 Watt Amplifier with built-in preamplifier and all controls. Net **59.50**
LJ-6K 10 Watt Amplifier (Little Jewel). Has built-in preamplifier and record compensator on phono channel. Net **24.95**
207A-K Hi-Fi Preamplifier (Self-Powered). Feedback circuit with 10 controls. Net **44.50**
250-K 60 Watt Basic Hi-Fi Amplifier. For use with a preamplifier (such as 207A-K). Net **79.50**

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LITERATURE *(Continued)*

catalog has 57 pages of make-it-yourself projects covering a wide variety of test instruments, amateur, hi-fi and marine equipment.—**Heath Co.**, Benton Harbor 20, Mich.

STEREO INFORMATION. *Bulletin E-305, "An Introduction to Stereophonic Sound,"* describes how a stereo disc is produced and tells what is needed for stereo playback. *E-306, "Hints on Using the Columbia CD Stereo Cartridge,"* describes the mechanics of the cartridge and recommends how to install and equalize it.—**CBS-Hytron Advertising Service**, Parker St., Newburyport, Mass.

TRANSFORMERS for all uses are listed in two 32-page catalogs. *No. S-104* has data on Stancor transformers, chokes and coils for TV, radio, industrial and communications applications. *CT8-58* lists the Chicago line of heavier-duty transformers and reactors and a series of special transformers. — **Chicago Standard Transformer Corp.**, 3501 W. Addison St., Chicago 18, Ill.

SLIDE-RULE catalog and buying guide entitled *Slide Rule—May I Help?* is an attractive 24-page 2-color booklet.—**Keuffel & Esser Co.**, Adams and 3d Sts., Hoboken, N. J.

RELAY CATALOG *C-9* has 66 pages listing thousands of types of relays of many manufacturers.—**Relay Sales Inc.**, Box 186, West Chicago, Ill.

FM TUNERS with crystal-oscillator circuits for home use are described and illustrated in a new catalog.—**Karg Laboratories Inc.**, 30 Meadow St., South Norwalk, Conn.

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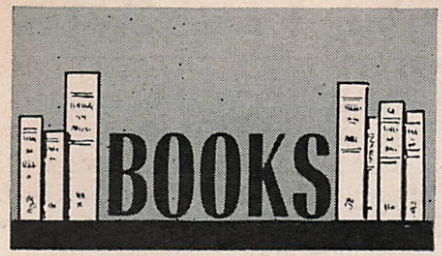
SILICON SOLAR CELLS now commercially available are described in 4-page *Technical Information Bulletin 32-58*, which gives complete design parameters and application notes on 9 types of cells with spectral response curves and other data.—**Hoffman Electronics Corp.**, Semiconductor Div., 930 Pitner Ave., Evanston, Ill.

1958 MASTER INDEX lists diagrams and service information in the "Most-Often-Needed" series of service manuals covering radio sets from 1926 through 1958 and TV sets from 1948 to date.—**Supreme Publications**, 1760 Balsam Rd., Highland Park, Ill. 5¢ for RADIO-ELECTRONICS readers. END

CORRECTION

A reader called attention to an error in the Heathkit Mohawk communications receiver circuit in December's issue. In the power supply diagram, bottom left corner, page 100, the line switch's right hand terminal should go to the lower end of the power transformer primary. The ac outlet connects directly across the primary.



MOST-OFTEN-NEEDED 1958 RADIO DIAGRAMS AND SERVICING INFORMATION. Compiled by M. N. Beitman. Supreme Publications, 1760 Balsam Road, Highland Park, Ill. 8½ x 10½ in., 192 pp. $2.50

A comprehensive selection of original manufacturers' service information covering 25 brands of phonographs and home, portable and auto radios.

SINGLE SIDEBAND FOR THE RADIO AMATEUR (2nd Edition—1958). American Radio Relay League, West Hartford 7, Conn. 6½ x 9½ in., 262 pp., including a 52-page catalog. $1.50 in US proper, $1.75 elsewhere.

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STEREOPHONIC SOUND, by Norman H. Crowhurst. John F. Rider Publisher, Inc., 116 W. 14 St., N. Y. 11, N. Y. 5½ x 8½ in. 118 pp. $2.25. (Published 1957)

This well-known author begins with a clear discussion of binaural listening and stereo sound. Then he tells the reader how to obtain maximum pleasure on a minimum budget. Key points are: suitable systems for the home; choice and placement of speakers; radio, disc and tape methods; how to record. All are clearly described and illustrated. Stereo disc recording is, however, given limited treatment, since it was then in the experimental stage.

A chapter on stereo for theatres and auditoriums is also included.—*IQ*

TV AND OUR SCHOOL CRISIS, by Charles A. Siepmann. Dodd, Mead & Co., 432 Fourth Ave., N. Y., N. Y. 5¼ x 8 in., 198 pp. $3.50.

Written by the chairman of New York University's Department of Communications, this nontechnical work reviews the experiences of schools with closed- and open-circuit TV and concludes that television offers promise of helping to solve many problems faced by education today and in the future.

ELECTRONICS MADE SIMPLE, by Henry Jacobowitz. Made Simple Books, Inc., 220 Fifth Ave., New York, N.Y., 8 x 10½ in. 192 pp. $1.

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(Continued on page 146)

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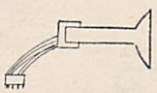

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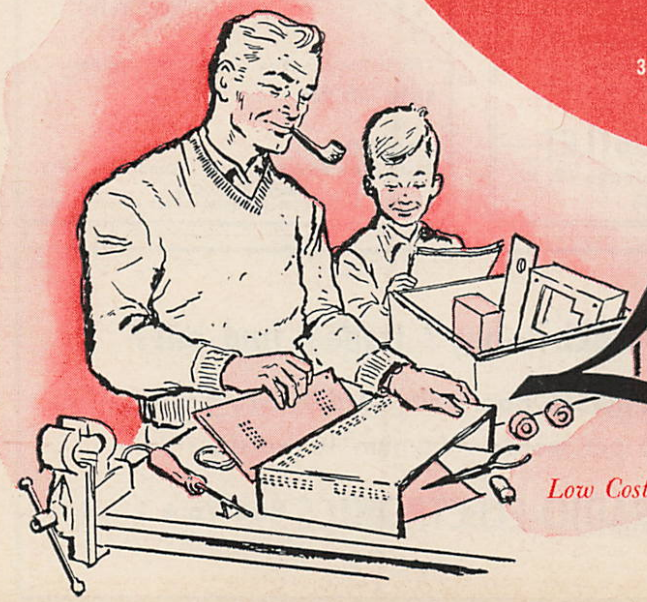

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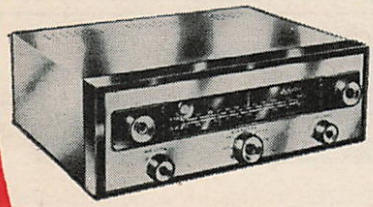

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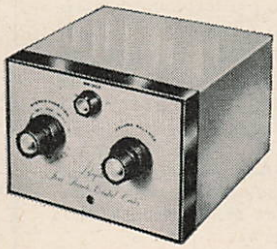

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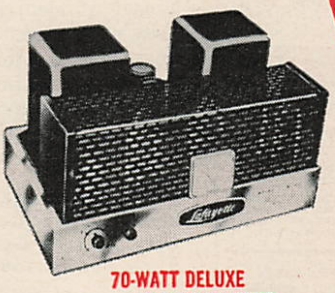

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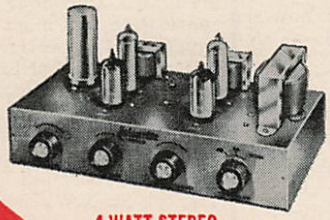

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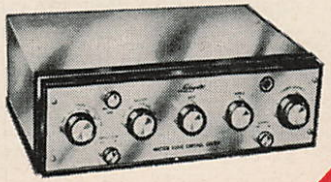

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BOOKS *(Continued from page 143)*

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Self-study readers will appreciate the summary at the end of each chapter. —*IQ*

RADIOISOTOPES, A NEW TOOL FOR INDUSTRY, by Sidney Jefferson. Philosophical Library Inc., 15 E. 40 St., N. Y. 16, N. Y. 5 x 7½ in., pp. $4.75.

Designed to give the businessman and layman a look at the many ways industry can use radioisotopes, when coupled with electronic detection devices, this book also has a section explaining the fundamentals of radioactivity, including atomic structure, atomic energy and atomic piles.

DC CIRCUIT ANALYSIS, by Alexander Schure. John F. Rider Publisher, Inc., 116 W. 14 St., N. Y. 11, N. Y. 5½ x 8½ in., 80 pp. $1.35.

A part of the Electronics Technology Series, this text covers a fundamental aspect of electricity. After a brief review of electrostatic principles, it introduces the reader to Ohm's and Kirchhoff's laws. This is done through the solving of various circuit problems. More advanced techniques are introduced in later chapters.—*LS*

TRANSISTOR MANUAL, 3d edition. General Electric Co., Semiconductor Products, 1224 W. Genesee St., Syracuse, N.Y. 5½ x 8½ in. 168 pp. $1.

New and useful data appear in this edition. Unijunction circuits, transistor switches, logic applications, silicon-controlled rectifiers are among the topics. Design data for class-A and -B amplifiers, transistor symbols and how to read specifications are included.

Practical circuits are shown for power supplies, radio receivers and amplifiers. Complete characteristics are given for G-E transistors. An interchangeability list gives JETEC types and the nearest G-E equivalent.—IQ

GRAPHIC SCIENCE, by Thomas E. French and Charles J. Vierck. McGraw-Hill Book Co., Inc., 330 W. 42 St., N.Y. 36, N.Y. 7½ x 10 in., 758 pp. $8.50.

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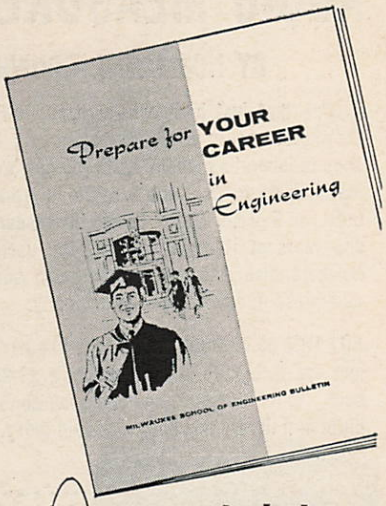

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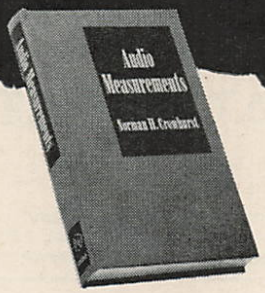

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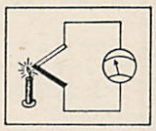

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rules and conversion charts are discussed in the final chapters. Each chapter ends with problems. A fine book for study or reference.—*IQ*

1958 OFFICIAL REGISTRY OF RADIO SYSTEMS IN THE TRANSPORTATION SERVICES. Communications Engineering Book Co., Radio Hill, Monterey, Mass. 8½ x 11 in., 84 pp. $4.

This registry, compiled from FCC records, gives details on every mobile radio system in the US operated by railroads, taxicabs, auto emergency services, buses and trucks. It lists the name and address of each company, the number and location of its fixed transmitters, the number of mobile transmitters authorized, operating frequencies, call letters and make of equipment used. Part 1 is a listing by companies. Part 2 by frequencies.—*RFS*

ELECTRICAL APPLIED PHYSICS, by N. F. Astbury. Philosophical Library, 15 E. 40 St., New York 16, N.Y. 5½ x 8¾ in. 241 pp. $10.

This text is suitable for senior students in physics or engineering. It derives the general laws of magnetic and electric fields and circuits, then applies them. Vectors are explained and used where necessary. Filters, bridges, networks, tubes, transistors and antennas are among the topics studied. Electromechanical and electroacoustic systems are also discussed. —IQ

VACUUM TUBE RECTIFIERS, edited by A. Schure. John F. Rider Publisher, Inc., 116 W. 14 St., New York 11, N.Y. 5½ x 8½ in., 78 pp. $1.50.

This book covers the subjects of rectifiers and filters as used in single- and polyphase power supplies. It compares and analyzes half-wave and full-wave rectifiers, bridges and voltage multipliers. Equations for filter design are given and typical examples are worked out. Attention is given both to theory and practice. END

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Radio-Electronics does not assume responsibility for any errors appearing in the Index below.

Acro Products Co. 98
Aerovox Corp. 107
Allied Radio Corp. 17, 86-89
Amphenol Electronics Corp. 116
Arkay Radio Kits Inc. 114
Atlas Sound Corp. 134

B & K Manufacturing Co. 22, 109
Barry Electronics Corp. 149
Bell Telephone Labs 24
Blonder-Tongue Labs 93
Brooks Radio & Television Corp. .. 137
Burroughs Corp. 125
Burstein-Applebee Co. 133

CBS-Hytron 30
Capitol Radio Engineering Institute 12, 101-102
Carston Studios 141
Castle Television Tuner Service .. 136
Centralab Division of Globe Union 18
Century Electronics Co. Inc. 121
Chemtronics Inc. 118
Chicago Standard Transformer Corp. 104
Cisin (H. G.) 132
Cleveland Institute of Radio Electronics 10-11
Colordaptor 138
Columbia Record Club 13
Cornell-Dubilier Electric Corp. .. 91
Cotter (Hermon E.) 148
Coyne Electrical School .. 23, 127, 137

Delco Radio Div. of General Motors Corp. 129
Deutschmann (Tobe) 81
DeVry Technical Institute 7
Dressner 141
Dynaco Inc. 103

Editors and Engineers 135
Electro-Voice, Inc. ..... Inside Back Cover
Electronic Chemical Corp. 138
Electronic Instrument Co. (Eico) 31-32
Electronic Measurements Corp. .. 100
Electronic Publishing Co. Inc. 100
E-Z Hook Test Products Inc. 100

Garfield (Oliver) Co. 141
General Cement Manufacturing Co. 128
Gernsback Library Inc. .. 140, 143, 148
Grantham School of Electronics .. 27
Gray Manufacturing Co. 8
Grommes 141
Guide Lamp Div. of General Motors Corp. 131

Heald Engineering College 141
Heath Co. 64-75, 77

Illinois Condenser Co. 138
Indiana Technical College 138
International Correspondence Schools 15

JFD Electronics 26
Jensen Industries 128
Jensen Manufacturing Co. ..... Inside Front Cover

Key Electronics 136

Lafayette Radio 144-145
Lansing (James B.) Sound Inc. .. 99
Lektron Inc. 139

Mallory (P. R.) Inc. 14
McGraw-Hill Book Co. Inc. 136
Merit Coil & Transformer Corp. .. 136
Mosley Electronics Inc. 134
Moss Electronic Distributing Co. Inc. 94-97
National Radio Institute 3, 19-20
National Schools 5

Opportunity Adlets 142-143

Pentron Corp. 130
Perma-Power Co. 90
Philco Accessory Div. 82-83
Philco Techrep Div. 150
Pickering & Co. Inc. 80
Picture Tube Outlet 143
Precision Electronics Inc. 113, 141
Progressive Edu-Kits Inc. 126

Quam-Nichols Co. 118
Quietrole Co. Inc. 130

RCA Electron Tube Div. ..... Back Cover
RCA Institutes 78-79
Radio-Electronic Master 120
Radio Shack Corp. 122-123
Rider (John F.) Publisher Inc. 117
Rinehart & Co. Inc. 28-29
Rogers Manufacturing Co. 128
Rohn Manufacturing Co. 111

Sams (Howard W.) & Co. Inc. .. 21, 92
Schober Organ Co. 142
Service Instruments Corp. 104, 115, 124, 133, 135, 139, 148
Sprague Products Co. 105
Sprayberry Academy of Radio-Television 25

TAB 146
Tarzian (Sarkes) Inc. 140
Television Tuner Service Co. 134
Thorens Co. 16
Trio Manufacturing Co. 124
Tung-Sol Electric Co. 6

University Loudspeakers Inc. 119
University Microfilms 148
Van Nostrand (D.) Co. Inc. 9, 123

Zamco 143

SCHOOL DIRECTORY PAGE 146-147

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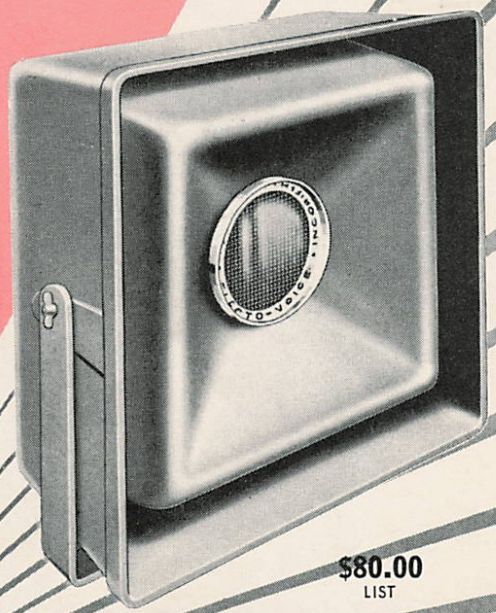

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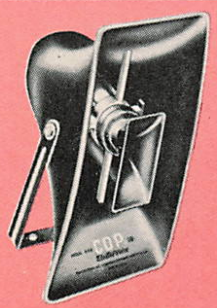

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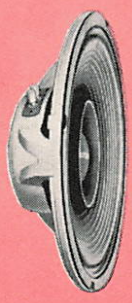

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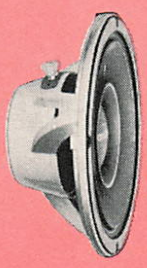

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